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Proceedings of the Sixth Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The sixth annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held in Room 212, Agricultural Hall, California University, Berkeley, California, August 4-5, 1921.

The first meeting was called to order at 9:00 a. m. August 4, by Chairman E. O. Essig. A brief business session was held at the opening of the session, followed by the presentation of papers; the session closing the afternoon of the fifth with the election of officers and other unfinished business.

The attendance was the largest and probably the most representative of any of our sessions. The symposium idea as attempted in the program met with enthusiastic approval; the discussions were general and lively; the provisions made by the local entomologists for the convenience and entertainment of the association most pleasing; and the meeting in every way a decided success.

PART I. BUSINESS SESSION

The business meeting was called to order by Chairman E. O. Essig at 9:00 a.m., August 4, 1920. Unfortunately no complete roster of attendance is available. The following were present:

Harry S. Smith, Sacramento, California.
S. B. Doten, Reno, Nevada.
F. B. Headley, Fallen, Nevada.
Geo. A. Coleman, Berkeley, California.
R. D. Hartman, Los Gatos, California.
B. B. Fulton, Corvallis, Oregon.
A. J. Basinger, Berkeley, California.
H. E. Burke, Palo Alto, California.

Edwin C. Van Dyke, Berkeley, California.
A. W. Morrill, Los Angeles, California.
A. L. Lovett, Corvallis, Oregon.
E. O. Essig, Berkeley, California.
Geo. P. Weldon, Ontario, California.
Donald D. Penny, Watsonville, California.
D. B. Mackie, Sacramento, California.
T. D. Urbahns, Sacramento, California.
Stanley S. Freeborn, Berkeley, California.
Cecil W. Creel, Reno, Nevada.
R. W. Doane, Stanford University.
V. M. Tanner, Stanford University.
E. A. Schwing, Salinas, California.
W. G. Hartung, Salinas, California.
F. H. Lathrop, Corvallis, Oregon.
A. O. Larson, Alhambra, California.
E. R. DeOng, Davis, California.
J. W. Hungate, Cheney, Washington.
W. Dwight Pierce, San Mateo, California.
W. W. Thomas, Berkeley, California.
W. B. Herms, Berkeley, California.
A. O. Dahlberg, San Francisco, California.
Roy E. Campbell, Alhambra, California.
Wm. B. Turner, Sacramento, California.
H. J. Quayle, Riverside, California.
Eubanks Carsner, Riverside, California.
C. F. Stahl, Riverside, California.
J. P. Martin, Berkeley, California.
J. M. Miller, North Fork, California.
Henry H. Severin, Berkeley, California.
E. P. Van Duzee, San Francisco, California.
R. E. Smith, Berkeley, California.
R. Rudolph, Mt. View, California.

The following committees were named by the chair:

Nominating: H. S. Smith, Chairman, A. W. Morrill, S. B. Doten.

Membership: R. W. Doane one year, Chairman, E. J. Newcomer, two years, Edwin C. Van Dyke, three years.

Auditing: Stanley S. Freeborn.

The report of the secretary-treasurer was then presented:

REPORT OF THE SECRETARY-TREASURER

FINANCIAL STATEMENT

1921.				
February	1.	On hand—	$24.60	
March	18.	Paid Affiliation fee to Amer. Assn. Adv. Sci.	5.00	
Aug.	1.	Stamps for mailing programs of Berkeley meeting	.90	
Aug.	2.	Telegram to President Re. program	1.66	
			$ 7.56	$24.60
Aug.	4.	Amount on hand		17.04
		Refund from Amer. Assn. Econ. Ent. Due		7.56

Morning Session August 5, 9:00 A. M.

Chairman E. O. ESSIG. I am in receipt of a Communication from President Dean of the parent association which I will take the liberty to read.

Manhattan, Kans. Aug. 4, 1921.

E. O. ESSIG:
University of Calif.
Berkeley Calif.

As President of the American Association of Economic Entomologists I am pleased to extend congratulations and greetings to the Pacific Slope branch of the Association upon the occasion of its sixth annual meeting. Your splendid meetings in the past and the program you have arranged for at this meeting speak well for the enthusiasm, energy and enterprise of its members. I am sure the entire membership of the American Association of Entomologists wishes the members of the Pacific Slope a most pleasant and profitable meeting. Very sincerely yours,

(signed) GEO. A. DEAN, *President*

Afternoon Session August 5

At the close of the formal presentation of papers the closing business meeting was held. The nominating committee reported as follows:

Report of Nominating Committee

The following were nominated for office during the ensuing year:
For Chairman, A. L. Lovett, Corvallis, Oregon.
For Secretary-Treasurer, E. O. Essig, Berkeley, California.
These were duly elected.

It was moved and carried that a program committee be appointed by the Chairman to act with the chairman and secretary as ex officio in the preparation of next year's program.

Following a discussion of some points regarding nomenclature of our western insect forms it was moved and carried that the Chairman appoint a Nomenclature Committee to pass upon matters of nomenclature for our western forms and submit recommendations to the parent nomenclature committee.

The following Committees were appointed:
Editorial: W. B. Herms, Chairman, H. S. Smith.
Affiliation: R. W. Doane, Chairman, E. C. VanDyke, H. E. Burke.
Program: H. J. Quayle, Chairman, D. B. Mackie, Ralph H. Smith.
Nomenclature: Edwin C. Van Dyke, Chairman, L. P. Rockwood, A. L. Melander. This concluding the session the meeting was declared adjourned until next year.

A. L. LOVETT, *Secretary-Treaurer.*

PART II. PAPERS AND DISCUSSIONS

Morning Session August 4, 10:00 a.m.

CHAIRMAN E. O. ESSIG: We will now proceed to the presentation of the formal program of papers. The first is a symposium: Nicotine Dust Sprays and Mechanical Devices in Insect Control[1].

[1] Unfortunately no records were made of the very interesting discussions of the papers given and these are, therefore, not included.

DUST INSECTICIDES IN CALIFORNIA

By E. O. Essig, *Univ. of California, Berkeley, Calif.*

Recent developments in the use of dust insecticides in California are the outgrowth of some investigations and experiments on the walnut aphis (*Chromaphis juglandicola* Kalt.) by Prof. R. E. Smith, of the Division of Plant Pathology, University of California, begun in 1914. Professor Smith had been doing considerable experimental spraying of walnuts for the control of walnut blight and it was in connection with this disease that aphis control was also undertaken. The desirability of a dust which could be quickly and cheaply applied was apparent, because the well-known nicotine and soap sprays were almost prohibitive on account of the great size of the trees. The first definite results were obtained by impregnating finely pulverized kaolin with "Blackleaf 40". For the walnut aphis a dust composed of 2% "Blackleaf 40" was found to be thoroughly adequate.

Orchard tests were so thoroughly satisfactory during the years following 1916 that a great impetus was given to the study of dusts in general with the results that rapid advance is being made along many new lines.

The development of the so-called nicodust was made by Professor Smith through the California Walnut Growers Spray Manufacturing Company which manufactured the material in large quantities particularly for members of the California Walnut Growers Association, but did not neglect to develop a general trade in the insecticide. The name nicodust originally given the mixture by Professor Smith has become so general that it will probably always be used to designate any dry material treated with a nicotine extract and is so used in most western articles dealing with such materials.

So great has been the interest in this material that it is now prepared by at least four large insecticide manufactureres and the number is increasing rapidly. Various combinations and mixtures of nicodust with sulfur, the arsenic compounds, fungicides, etc. are also appearing in rapid succession until the orchardist is faced with a serious problem in selecting the really efficient and less expensive article. At the present time lime has practically replaced kaolin, because it liberates the volatile nicotine more readily and therefore gives better results.

Many experiments were and are still being conducted by the manufacturers and others to determine the efficiency of nicodust and its various combinations for different insect pests and plant diseases. Professor Smith did considerable along this line, particularly in the control of aphids and the onion thrips.

Mr. R. E. Campbell, Bureau of Entomology, United States Department of Agriculture has summed up a long series of experiments on "Nicotine Sulphate in a Dust Carrier Against Truck Crop Insects" in Circular 154 United States Department of Agriculture issued February 21, 1921.

It occurred to the writer that this material might prove satisfactory as a control for pear thrips and two seasons' experimental work has demonstrated this conclusively as originally stated in Circular No. 223 of the University of California, Agricultural Experiment Station, issued in November 1920.

During the past season there has been a large accumulation of data obtained chiefly by entomologists relative to the different insects which may be controlled by various strengths of nicodust. Among those receiving the most attention may be mentioned:

Aphids—Various aphids, excepting those which are protected by a waxy covering like woolly apple aphis and mealy plum louse. The writer conducted a series of experiments on most of the common garden species and found that practically all were easily killed with a 5% or 6% "Blackleaf 40"[1] mixture. Investigations conducted in Sonoma County on the purple or rosy apple aphis (*Aphis malifoliae* Fitch) were very promising and good control was obtained on the infested plots where dusting was begun as the leaf buds opened and continued until the winged aphids began to migrate in from the untreated areas. Experiments covering a period of two years in the melon aphids conducted by various farm advisors and others were reported successful in all cases where a 6% dust was used.

Grape leafhopper—Some apparently successful demonstrations on the control of *Erythroneura comes* (Say) were made by at least two different distributors of nicodust in the San Joaquin Valley. These demonstrations indicated that a 6% dust would kill all nymphs, but that it required a 10% dust to destroy the adults.

Hairy Caterpillars—From many experiments conducted by the writer and others on such hairy caterpillars as those of the tent caterpillars (*Malacosoma* spp.) brown day moth (*Pseudohazis eglanterina* Boisd.); the fall webworm (*Hyphantria cunea* Drury); the chalcedon butterfly (*Lemonias chalcedon* D. & H.); the thistle butterfly (*Vanessa cardui* Linn.) and the West Coast Lady (*Vanessa caryae* Hubn.) indicate that the young readily succumb to nicodust treatment.

False Chinch Bug—During this summer the false chinch bug (*Nysius ericae* Schilling and the small variety *minutus* Uhler) appeared in very

[1]Percentages refer to the quantity of "Blackleaf 40" in all cases.

destructive numbers in many localities in California from Imperial Valley to the central part of the state. In one instance at least it is reported to have been successfully controlled by a 6% nicodust.

Combinations of Nicodust

There has also been collected a great deal of miscellaneous data on the various combinations of sulfur, arsenic compounds and fungicides on insect control. The use of lime instead of kaolin to produce a more efficient dust by liberating pure nicotine to be further fortified by the addition of dry sulfur at the time of mixing for nicosulfur dusts appears from many experiments conducted under widely different conditions upon various insects, to be more efficacious than nicodust of the same strength without the sulfur. When sulfur alone is treated with "Blackleaf 40" it appears to increase the efficiency of the nicotine over lime alone, but because of its weight it is not as easily handled in the dusting machines as is the regular nicodust.

Mixtures of nicodust and powdered arsenate of lead were very efficient in controlling caterpillars and flea beetles, particularly the latter on tomatoes.

Dusting for the control of the codling moth has received a considerable impetus and a large number of experiments are under way, mostly conducted by orchardists or insecticide manufacturers. We are contemplating a definite series of experiments along this line next year.

The revival of tobacco dust is also to be noticed and many mysterious "kill all" mixtures are being put on the market as rapidly as possible.

In conclusion I feel certain that there is a great future for dust spraying. As yet it has hardly been touched. The development of new machinery is also uncertain. The two must go hand in hand. As entomologists we should take an impartial view and do all in our power to bring about the very best possible conditions for the profitable production of clean and wholesome agricultural products by the elimination of insect pests by the most efficient and economical means.

NOTES ON THE USE OF NICOTINE DUSTS

By A. W. Morrill

Consulting Entomologist

During the past few months the writer has given considerable time to investigations of nicotine dusts for the California Sprayer Company, manufacturers of a well known dusting machine and of a brand of nicotine insecticides. Work has been done with many species of insects but the

results which I have to offer at this time are for the most part fragmentary. However, it is hoped that the miscellaneous observations here recorded may prove of some value to others.

Observations on the Use of Nicotine Dusts Against the Grape Leaf-Hoppers

It was found by various investigators in the season of 1920 that the grape leaf-hoppers were susceptible to the effects of nicotine dusts but to what extent these insects were actually killed seems not to have been definitely determined. Reports in regard to the effectiveness of nicotine dusts against the leaf-hoppers became rather conflicting early in the present season and field tests were consequently undertaken in the Imperial Valley and later in the San Joaquin valley to discover the facts in regard to this question.

As a basis for work against the grape leaf-hoppers it was considered necessary to make a study of the methods of checking results of nicotine dust applications in vineyards. The method in common use consisted in spreading papers or canvas under the vines to be dusted and observing the hoppers which dropped on these comparatively smooth surfaces. Other observers modified this method by dumping the dead and stupefied insects from papers or canvas into pasteboard boxes or glass jars together with the dust which had dropped from the vine with the insects. By these methods an element of uncertainty was introduced by the assumption that the dusts which had dropped from the treated vines had lost all toxicity.

Among the methods tested by the writer were: (1) observing hoppers which dropped onto papers and canvas spread under the vines (2) observing hoppers which dropped into an old galvanized bucket with rough bottom (3) observing hoppers picked up with forceps from papers and canvas within five minutes after applying dust to the vines and kept in glass jars or vials (4) observing hoppers which dropped into a galvanized bucket within five minutes from the application of dust to the vine and which were dumped into a wire sifter to separate from dust and then into a glass jar for observation (5) observing hoppers which dropped onto a fine wire screen (about 50 mesh) through which most of the dust immediately passed and (6) observing hoppers which were left lying as they fell on the ground under the vines.

The last mentioned method was the most tedious but was necessarily the standard. The use of a fine wire screen (the inverted top of an insect breeding cage was used in this observation) appeared to give results which approximated those obtained by the standard method and the

insects were much easier to locate and keep under observation. When the insects dropped onto papers spread on the ground even a slight breeze had a tendency to blow the insects and dust together in depressions giving far from normal conditions. One would naturally suppose that by carefully picking up adults which had fallen onto canvas and dropping these into glass jars the insects would be under conditions as favorable for recovery as though they were lying on the ground under the plant. This however, does not appear to be the case. When collected in a bucket placed under the dusted plant and the dust sifted from the mass of insects a very noticeable difference in the percentage of recovery was noted in tests with different lots of dust. It has not been determined whether this is entirely due to a difference in toxicity or is partly due to other factors, such as air movement affecting the amount of dust adhering to the insects.

In order to determine whether field results from different lots of dust corresponded with the nicotine content two sample dusts which apparently were of low toxicity were analysed[1] for comparison with two other lots of similar dusts of apparently high toxicity. The analyses and field results are shown in the following table:

Lot no.	1	2	3	4	aver. 1&2	aver. 3&4
Percentage adult leaf hoppers recovered	14.3	25.	1.5	0	19.6	.72
Nicotine shown by analysis of sample	1.95	1.76	1.30	1.25	1.85	1.27

Field tests of lots 2, 3 and 4 were made on June 16 in the same vineyard near Fresno within a period of 1 hour, using exactly the same methods. All conditions were supposedly practically identical. The test of lot 1 was made in another vineyard on the preceding day. No difference was noted in temperature or wind conditions which could account for the difference in killing effects as compared with the other three samples. In these tests the insects dropped into a bucket and were separated from the dust by means of a sieve, then kept in closed Mason jars for observations.

In another field test using a nicotine dust which analysed 2.23% nicotine the field tests showed results strikingly inferior to those with a dust of exactly the same composition but with only 1.55% nicotine. These tests were made near Holtville in the Imperial Valley, one application immediately following the other and all conditions supposedly practically identical. The insects were collected on canvas spread under the vines, picked up carefully with forceps and kept in vials for observation. Eleven

[1]Analyses made through cooperation of Prof. Gray, Chief Div. of Chemistry, Cal. Dept of Agric.

out of 40 adults recovered within two hours in case of the vine dusted with the 2.23 dust whereas with the 1.55% dust only one adult out of 75 under observation recovered during a period of 7 hours.

No conclusions should be drawn from the foregoing observations except to the effect that either the nicotine content does not necessarily indicate the relative toxicity of nicotine dusts of otherwise practically identical chemical composition or that the methods described for securing the results are of very questionable dependability.

As already noted the standard method of checking results of dust applications consists in observing the insects on the ground under the treated plant. On June 18, Mr. A. J. Flebut of the U. S. Bureau of Entomology, and the writer undertook to determine the difference in the percentage of recovery of adult leaf-hoppers left on the ground under dusted vines, on screens and in buckets. Of 109 adults under observation 56 were in buckets and none of these recovered, 40 were on fine wire screens and of these 28 recovered while 13 were on the ground where they fell from the vines and of these 11 recovered. Of 21 nymphs under observation in the same tests, all on the screens, 7 recovered. These figures do not necessarily indicate the value of dusting for the leaf-hoppers since many of the insects, both nymphs and adults, drop onto the upper surfaces of leaves where they remain in contact with dust and apparently are under as unfavorable conditions as the adults which were under observation in the bucket. Furthermore many or most of the nymphs which recover on the ground probably fail to get back on to the plants. This probably explains the reason why satisfactory results were reported by many vineyard owners who used the dusting method early in the season. In the tests above mentioned dusts were used in which 7½% and 10% of Blackleaf 40 were used in manufacture, the analysis showing 2.4 and 3.8% of nicotine respectively; the former with 90% hydrated lime and 10% sulphur as a carrier and the latter with a carrier composed of approximately 75% sulphur and 25% lime.

From the writers observation it appears that the use of ordinary nicotine dusts against the grape leaf-hopper is of little value against the adults.

Against the nymphs the value appears to consist in stupefying a large percentage causing them to drop. Early in the season before the vines have runners lying on the ground or in the case of trellised vines, this probably is equivalent to killing a large percentage of the insects.

In certain experiments in which a second application of dust was made to vines from one to 24 hours after the first, it was estimated that the first application caused 100 per cent of the nymphs to drop in the first

experiment, 95% in the second, and 95.2% in the third. The number of nymphs counted in the three experiments was 46,106, and 681 respectively. The foregoing tests were somewhat less dependable in the case of the adults since some of those which did not drop from the first application may have left the plants. In one test however in which a square block of 16 vines was dusted, a second thorough dusting 24 hours after the first showed that about 55% of the adults had been killed or had disappeared from the central block of four vines. Nine hundred and seventy-four adults were included in this count. Only those which dropped from each vine into a bucket within five minutes after the dust was applied were included, the estimated total for the average plant being about 1700.

Observations on the Use of Nicotine Dusts Against the Melon Aphis

Investigations of the writer in the Imperial valley and other points in Southern California have not developed much of practical value to add to the discussion of melon aphis control presented by Mr. Roy Campbell in Circular 154 of the U. S. Dept. of Agriculture. For scattering infestations the writer advises nicotine dusts with not less than 2.4% nicotine. This requires about 7½% of Blackleaf 40 in manufacture. The expense in this case is partly for insurance of the uninfested plants against the spread of the insects. When the infestation is general throughout the field and the problem has become one of reasonable control for the purpose of maturing a marketable crop, with no consideration for restriction of spread, a dust with about 1.5% of nicotine, or 4 or 5% Blackleaf 40 used in manufacture, is to be preferred.

The need of early season scouting or patrolling of the melon fields to locate incipient aphis colonies cannot be too strongly emphasized. Paradoxical as it may seem, the most expensive treatment on a basis of cost per hill is the most economical. Growers can better afford to spend $4.00 a day for patrolling in early season when a man can find only one or two infested plants each day, at a cost of two to four dollars per hill for labor alone, than he can afford 5c a hill for both labor and material in dealing with a general infestation when the melons are beginning to mature. If a commercial melon field were so generally infested throughout as to require treatment of all the vines with an insecticide to save the crop, the cost of dusting would be prohibitive. Such a condition seldom if ever occurs however, since ordinarily by the time such a widespread infestation has developed a large percentage of the plants are already dead.

An attempt was made to overcome the interference of high winds and to reduce the amount of material needed per plant by using a canvas cover to confine the dust. Areas about three feet square were covered with eight ounce duck held 2 to 4 inches above the leaves of the vines and with side pieces extending to the ground. From one-fifth to one-fourth of the amount of dust normally required was used per plant, discharging the dust at different parts of the enclosure in different tests. These results did not encourage the belief that the use of covers could be used to advantage with the dusting process.

In the Imperial Valley late in May and early in June, with maximum daily temperatures ranging between 93 degrees and 103 degrees, nicotine dusts containing approximately 75% sublimed sulphur caused burning of canteloupe plants.

A single infested watermelon plant treated with such a dust May 29th showed no injury, the aphids being completely eradicated. Pure sulphur applied as a check to canteloupe plants on June 1 had caused no noticeable damage two days later but on June 5 it was noted that the dusted vines were badly burned. While nicotine sulphur dusts may not cause any damage to canteloupes where the temperatures are more moderate than in the Imperial Valley it appears safer to avoid the use of dusts on this crop containing more than 10% sulphur.

Special mention should be made of the relation between nicotine dusts for the melon aphis and the natural enemies of this pest. During the period mentioned above, adult lady bugs were very abundant in the melon fields but there were very few eggs and larvae present. Hymenopterous parasites were remarkably scarce. The most active natural enemy was a species of syrphus fly. A similar situation with regard to melon aphis natural enemies was noted at Burbank near Los Angeles, during July. The adults and larvae of lady birds (*Hippodamia convergens*) and the larvae of the syrphus flies (species unknown) were apparently uneffected by the nicotine dusts used in the experiments.

In tests of nicotine dusts against the melon aphis near Los Mochis, Sinaloa, Mexico in March 1921 it was noted that the adults of hymenopterous parasites (*Aphidius testaceipes*) were apparently not affected by dusts which were satisfactory against the aphis. The aphids which survived the dust, located mostly in curled leaves, received the concentrated attack of the parasites resulting in almost complete eradication of the pests.

Observation on Nicotine Dusts Against The Woolly Apple Aphis

Prof. P. J. Parrott has reported[1] nicotine dusts as strikingly ineffective against the woolly apple aphis in his experiments. This is as would be expected but for some reason the writers preliminary tests have shown remarkable susceptibility of this species to nicotine sulphur dusts averaging about 1.6% nicotine[2] and somewhat less susceptibility to a dust containing over 2% nicotine with a carrier composed of 90% lime. Although only a few infested trees have been available for this work, repeated applications have given uniformly good results. The writer has had experience in the use of nicotine soap solutions against the woolly aphis but in the preliminary dusting experiments here referred to, obtained better results with less effort than previously with the wet applications.

Using the dusts mentioned above colonies of the aphids were frequently completely eradicated on small trees with dust blown from a distance of three or four feet with not enough air pressure to disarrange the waxy covering of the insects and with so little dust remaining attached to the wax as to be scarcely noticeable to the naked eye. The difference in the results obtained by Professor Parrott and the writer may be due to the difference in nicotine content of the dusts tested or perhaps to the dusting machine used by the writer being better adapted for the work. The applications here recorded were made with temperatures ranging from 75 to 85 degrees but no relation between the temperatures and the results was noted.

TWO MECHANICAL DEVICES FOR CONTROLLING WESTERN CUCUMBER BEETLES

By Roy E. Campbell, *Assistant Entomologist*, and Walter H. Nixon[3]

In the State of California the western twelve-spotted cucumber beetle (*Diabrotica soror* Lec.) known locally as well as somewhat generally as *the* "Diabrotica," and erroneously as the "green ladybird", causes considerable damge each year.

The beetle is a very voracious and universal feeder, the number of its food plants being placed at over five hundred. From a commercial standpoint, the injury is confined mostly to crops such as beans, cucumber, alfalfa, beets, pumpkin and melons. The injury of cucurbits is to the stems and leaves of the young plants; of alfalfa and beets it is to the

[1] Jour. Econ. Ent. Vol. 14, p. 211.

[2] The writers statements of nicotine content refers to the results of analyses of the manufactured dust and not to the amount of nicotine added to the carrier.

[3] Assistant Superintendent, Trial Grounds, C. C. Morse & Co., San Carlos, Cal.

foliage; while on beans injury is to foliage, blossoms and pods. In a number of bean fields examined, when the leaves, blossoms and young pods had been injured, less than 50 per cent of the pods on a plant had developed. On many plants, especially near the edges of the field, only one or two pods were left. A typical severely damaged plant showed the foliage badly eaten and only one pod developed, while a typical undamaged plant from the same field had eighteen well developed pods. Often pods are found with large holes eaten in them, rendering the beans unfit for market. In several fields of wax beans, a number of counts were made, which showed that the percentage of injured pods ran as high as 60 on some plants, while the average loss for the fields was 28 per cent.

Remedies for this pest have been rather unsatisfactory. The use of an arsenical spray has been unsuccessful in that it kills only a small percentage of insects. Repellents have also been of little value.

While walking through a field of young cucumbers which was being damaged by Diabroticas, it was noticed that when the beetles were disturbed, many flew up, usually taking a course close to the ground. This suggested the idea that perhaps such a machine as a hopper-dozer would catch many of these low-flying insects. Accordingly it was tried out. A board, 1″ x 12″, fifteen feet long, was fastened on a pair of runners, 2″ x 8″ x 5′. These runners were placed 5 feet apart. As the bean rows were 30 inches apart, the board would cover six rows at a time, two between the runners, and two on each side. To the back edge of the board a framework three feet high was nailed, to which a strip of canvas was tacked. The upper surface of the board, and the front side of the canvas were smeared with a thin layer of tangle-foot. This apparatus was drawn across the field by a horse. The lower board struck just a little below the tops of the plants in the rows. It was tried several times but did not prove the hoped-for success. The beetles, on rising, would fly just ahead of the canvas, or rise up and fly over the top. Even with a hood extending 30 inches forward from the top of the canvas, only 1800 beetles per acre were caught.[1]

Then a galvanized iron pan, 15 feet long by one foot wide by one inch deep, and properly braced along the back and sides, was substituted for the board. The pan was partially filled with an oil heavy enough to avoid slopping over. The pan rested low enough on the runners so that in going along the rows it struck about two inches below the tops of the plants. When the pan struck the plants, many beetles were shaken loose and thrown back into the oil. In fact, a majority of the catch was

[1]Also 250 tarnished plant-bugs (*Lygus pratensis* L.) and 100 lady birds, mostly *Hippodamia convergens* Guer.

composed of those which were thrown back in this manner. Care was taken that none of the apparatus touched the plants ahead of the pan, otherwise many beetles would be disturbed too soon, and escape before the pan reached them. A few leaves and blossoms were also caught in the oil, but the amount was negligible. The above outfit gave a catch of over 2000 per acre, but, as many of the beetles escaped by flying away, a wire screen hood was added, which resulted in raising the catch to 3500 beetles per acre.[1]

The hood was made of a 3-foot wire screen, 15 feet long, which was tacked to the framework at the back of the pan, with the edge of the screen extending down inside the pan, and curved upward and forward to about a foot and a half above the pan (Figure 8). The advantage of the screen hood over the canvas is the same as that of a screen fly-spatter over a solid one, i.e., it permits the passage through of air when in motion.

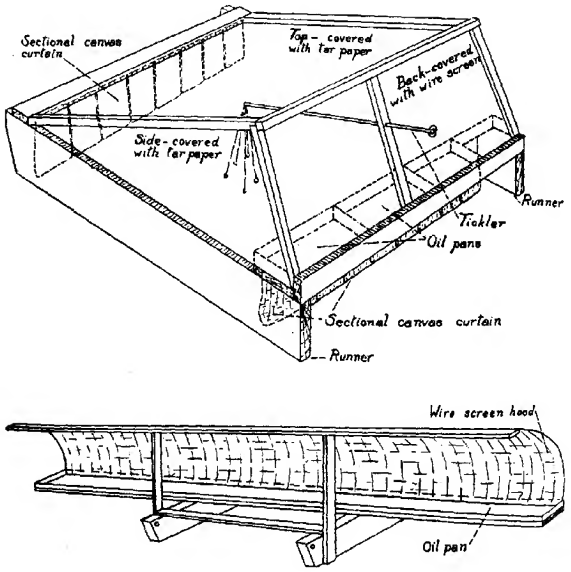

Fig. 8

Fig. 8. Mechanical Devices for Capturing Cucumber Beetles: Lower, adapted for crops grown in rows; Upper, for crops grown in hills. (Original)

[1]Also 350 tarnished plant bugs.

With the above apparatus a man and one horse easily covered thirty acres per day, at a very low cost per acre. As one farmer expressed it, each beetle if left in the field, will destroy at least one blossom or pod, besides doing some damage to the foliage, and by catching 3500 beetles, there will be at least 3500 more pods to the acre, which is approximately 35 pounds.

Of course, such a machine failed to catch many of the beetles the first time, but the low cost of the operation permitted going over the field once or twice a week for several weeks which greatly reduced the amount of damage to the crop. It is known that when food is plentiful, the beetles do not travel far, but remain near their favorite food plant.[1] So with plenty of food, as is usually the case, a reinfestation of the cleaned field would be unlikely.

The best time to catch the beetles was found to be about 10 a.m. and 3 p.m., and a quiet, cool day was better than a hot, windy one. The present cost of the apparatus described above is $3.50 for the galvanized iron trough, $2.25 for the wire screen, and $1.25 for the lumber, making a total cost of $7.00 for material. The catcher can be easily and quickly made.

Such a machine would be serviceable for capturing the beetles infesting any low-growing crop, such as beans, beets, cucumbers, etc., grown in rows, and also such crops as alfalfa up to the time it is about half grown.

The western striped cucumber beetle (*Diabrotica trivatatta* Mann.) also causes extensive damage. This species, however, confines its feeding largely to cucumber, squash and related plants, often causing almost complete defoliation. It also feeds on the stems of young plants which many times results in killing the plants outright. Later blossoms and fruit may be badly damaged.

In 1917 and 1918 the pumpkins and squashes grown by one of the canning companies were severely damaged by cucumber beetles. Both *trivitatta* and *soror* were present, though the former predominated. Since the plants were in hills the machine described above was not entirely suitable, but a similar machine on the same general plan was developed which proved entirely satisfactory. The principle of this Diabrotica catcher was as follows: Cover the entire plant with an opaque box, with light showing only from one side. Cover this side with a tilted wire screen, under which is an oil trough. Place the catcher over the plants and the beetles being aroused, fly toward the light, hit the screen and fall

[1]Journal Econ. Ent. Vol. 8, No. 6, pp. 517-18, by R. A. Sell.

into the oil. The catcher is illustrated in Figure 8. The runners, which straddled the hills, were made of 2 by 12 inch rough pine. They were 6 feet apart and about 8 feet long. The size of the machine should be made large enough to cover the growth of the plants, until all danger of attack is past. The top and sides were light wooden frames, entirely covered with roofing paper. The back frame was covered with screen wire. Directly under this was an oil trough made by cutting 5-gallon oil cans in half longitudinally and fitting them closely together end to end. This made a cheap trough and the cross divisions prevented splashing. Canvas curtains were hung between the runners, both in front and at the back, to shut out entirely all the light, except that which came through the screen. These curtains were made of strips of canvas about a foot wide, which overlapped, so that they would easily pass over the plants, and close as quickly as possible afterward, keeping out the light. Before these curtains were used many beetles escaped under the ends of the machine. The "tickler" was a rod extending through the back screen with light weights on strings at the inside end. The rod fitted loosely in a hole through a cleat across the middle of the screen, so that it could be moved freely from side to side, up and down, and also in and out, and the beetles in all parts of the plants could be disturbed.

In practice the catcher was drawn by two horses and operated by one man. The machine was stopped over each hill and the beetles stirred up. When first disturbed, a large proportion of the beetles dropped to the ground, then immediately crawled up on some projection and flew toward the light where they hit the screen and fell into the oil trough[1]. The longer the machine stayed over a hill, the larger the catch, but it was determined that all things considered, a pause of about 30 seconds was best. With a stop of this length, 75 to 80 per cent of the beetles were captured, and the work could be conducted at an average rate of 100 hills per hour.

This machine was used for two successive seasons and proved very satisfactory. In 1918 a small machine about 2½ feet square was made. This was set by hand over small summer squash plants. It worked well and proved entirely satisfactory while the plants were small enough to be covered by it.

[1]These movements of the beetles were definitely demonstrated as one of the authors spent almost an entire day inside the machine, observing their actions under various conditions.

EXPERIMENTS WITH A DUSTING MACHINE TO CONTROL THE BEET LEAFHOPPER (*EUTETTIX TENELLA* BAKER) WITH NICOTINE DUST

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The first experiments involving the use of dust preparations were carried out on a small scale by Mr. W. W. Thomas to control the beet leafhopper (*Eutettix tenella* Baker). The work was conducted near King City in the Salinas Valley during the 1919 outbreak of the pest. Dusting operations were started in the early part of July and continued until the return flight of the overwintering adults to the foothills had occurred during October.

Daily applications of dust mixtures were used at first to determine the relative value of the insecticides. The plots of beets comprised 1/100 of an acre or 12 rows, 20 feet long. Five rows of beets in each plot were dusted as soon as the seeds germinated and seven rows received no treatment. In later experiments the dust preparations showing a possibility of results were applied daily, biweekly and weekly on larger plots of beets. These plots consisted of 1/10 of an acre or 25 rows 100 feet long. Twelve rows in each plot were dusted and 13 rows were used as a check. The dust was applied with a hand duster. The percentage of curly leaf existing with the use of different dust mixtures at the end of six weeks is indicated in table I.

TABLE I

Dust mixtures	Applications	Dust per acre lbs.	Curly leaf dusted plots %	Curly leaf check %	Cost of one dusting per acre
				62.8	$6.83
"Black Leaf 40," 10% Kaolin and Lime	daily	40	.4		
	biweekly	40	10.3	57.1	
	weekly	40	24.4	53.8	
Arsenate of Lead, 10% Kaolin	daily	40	2.8	58.7	$2.00
	biweekly	40	30.0	84.9	
	weekly	40	55.3	92.5	
"Black Leaf 40", 5% Kaolin and Lime Arsenate of Lead, 5%	daily	40	1.7	31.0	$4.42
	biweekly	40	9.7	34.2	
	weekly	40	20.9	54.5	

With the harvesting of beets in the vicinity of the experimental fields an enormous congregation of adults was caused in the plots and hence no definite conclusions can be drawn as to the value of the dust as a method of control. When the summer broods make their appearance, flights on the part of the males associated with mating have been observed in other

valleys and in all probability, when beet fields are not isolated invasions from field to field occur. On the other hand, most of the adults which fly into the beet fields during the spring are females which have mated on the plains and foothills and in all probability, the females at the egg-laying stage make only short flights from beet to beet for the purpose of disseminating the eggs. The percentage of curly leaf increases rapidly with the appearance of the summer generations which is not the case when the spring brood invades the beet fields unless the pest is unusually abundant. It is evident that no conclusions should be drawn as to the value of the dust preparations against the summer broods, and dust mixtures should be tested when the spring brood first makes its appearance in the beet fields.

During 1920, a Niagara dusting machine was remodeled and various types of dusting nozzles enclosed in a sheet-iron fumigation box were tested. One type of nozzle terminating in two flattened tubes (Pl.5 fig. 2) blow the dust toward the lower surface of the leaves of two rows of beets. The nozzle which terminates in the funnel-shaped enlargement (Pl.5 fig. 2) is provided with a sieve-plate and forces the dust between the petioles of the leaves.

During the 1920 outbreak of the beet leafhopper, an attempt was made to control the pest with the use of a dust mixture in a beet field near King City, in the Salinas Valley. The experiment was conducted on the Oxnard tract of Ranch 3, which contained about 900 acres of beets. Two lots containing 7.6 acres of beets planted in February were selected, isolated on one side by foothills and surrounded on all other sides by beets. One of the lots of 7.6 acres was divided into four plots and dusted with "5% Nicodust" and the other 7.6 acres was divided into two plots and dusted with "10% Nicodust." "Nicodust 5% and 10%" however, contain only 2% and 4% nicotine, since "Black Leaf 40" contains 40% nicotine sulphate by weight. The dust was applied from 6–10 a.m. before the heavy winds started to blow. The number of applications and the amounts of dust per acre follows:

May 13, plots	1,	2,	3,	4	dusted with about 50 lbs. "Nicodust 5%"
May 20, plots		2,	3,	4	dusted with about 75 lbs. "Nicodust 5%"
May 27, plots			3,	4	dusted with about 75 lbs. "Nicodust 5%"
June 3, plot				4	dusted with about 100 lbs. "Nicodust 5%."
Number of applications	1	2	3	4	

May 14, plots	1,	2	dusted with about 75 lbs. "Nicodust 10%."
May 28, plot		2	dusted with about 75 lbs. "Nicodust 10%."
Number of applications	1	2	

The pale green adults of the spring brood invaded the beet fields at King City about April 22 or 23. When the foliage was disturbed with the hand during the early quiet morning, the adults were sluggish on account of the low temperature and usually hopped or made short flights and by this method it was determined that there was approximately one adult to ten beets in the experimental plots on May 2.

After the first application of "5% and 10% Nicodust" at the rate of about 50 and 75 pounds per acre respectively, there was no apparent reduction in the number of leafhoppers. In later treatments there was no noticeable decrease in the number of hoppers with "5% Nicodust" at the rate of about 75 and 100 pounds to the acre nor with "10% Nicodust" at the rate of about 75 pounds per acre.

The percentage of curly leaf before the first application of the dust in each lot of 7.6 acres and two checks was determined by an examination of 2000 beets as follows: May 12, 15% in plots before treating with "5% Nicodust," check 19%; 22% in plots before treating with "10% Nicodust," check 12%. The percentage of curly leaf after the application of the dust was determined from 100 beets in each plot and 200 beets in the two checks as follows:

Treated with "Nicodust 5%."

Plot 1, May 21, 26%,	May 28, 34%,	June 14, 66%.	
Plot 2, May 21, 26%,	May 28, 30%,	June 14, 56%.	
Plot 3, May 21, 18%,	May 28, 21%,	June 14, 52%.	
Plot 4, May 21, 19%,	May 28, 18%,	June 14, 47%.	
Average	22.2%	25.7%	55.2%
Check May 21, 29%,	May 28, 34.5%	June 14, 63%.	

Treated with "Nicodust 10%."

Plot 1, May 21, 24%,	May 28, 26%,	June 14, 43%.	
Plot 2, May 21, 24%,	May 28, 29%,	June 14, 57%.	
Average	24%	27.5%	50%.
Check May 21, 20%,	May 28, 27.5%,	June 14, 50.5%	

The cost per acre of one application of "Nicodust 5% and 10%" and labor including two men, team and gasoline was as follows:

Cost of 100 lbs. "Nicodust 5%" @ 13c per lb.	$13.00
Cost of applying dust	1.25
Total	$14.25
Cost of 100 lbs. "Nicodust 10%" @ 19c per lb.	$19.00
Cost of applying dust	1.25
Total	$20.25

It was afterwards found that "Nicodust" manufactured by the Walnut Growers Spray Manufacturing Company was not uniform in strength. Beet leafhoppers were confined in screen wire cages (Pl. 8, fig. 1) and the dusting machine passed over these cages in a beet field. Five sacs of "5% Nicodust" applied at the rate of about 125 pounds per acre showed a variation in the killing of the adults from 8-72%.

With the use of "10% Nicodust" one of the men working on the dusting machine was overcome with nicotine. The army gas mask was then employed and no further trouble was experienced by the operator.

During 1921, Hartung and Schwing conducted a series of experiments in order to make a dust mixture which is uniform in strength and efficient in killing the beet leafhopper. The same ingredients were employed in the dust preparation as were used last year.

Preliminary tests with reference to the effectiveness of the dust mixtures in killing the beet leafhopper were conducted in Little Panoche Pass. The vegetation was dry for the most part on the foothills but nymphs and adults had congregated on green Filaree growing in the gullies. An area about 20x10 feet was swept with an insect-net at the rate of 100 sweeps and an average of 34 hoppers was estimated: then the plot was dusted and the number of bugs captured in 100 sweeps was again ascertained. One hundred hoppers were also confined in screen wire cages (Pl. 8, fig. 2) and after dusting the percentage of kill was determined. A dust containing 8% "Black Leaf 40" was applied with an American Beauty hand duster. The percentage of leafhoppers that were killed in four cages varied from 87-97%. It was found that a few adults recovered but most of these died at the end of 20-45 hours when further observations were discontinued. Nymphs and adults were rarely captured in an insect-net by sweeping the dusted area.

Preliminary experiments conducted with a dusting machine in a beet field at King City showed that dust mixtures about six weeks old kept in closed tin receptacles and containing from 6-10% of "Black Leaf 40" were not as effective as the newly made material. The percentage of

EXPLANATION OF PLATE 5.

(1) Dusting machine in operation. The nozzles are enclosed in a sheet-iron fumigation box. Insert shows screen wire cage which was rolled below dusting machine in operation to determine the percentage of beet leafhoppers killed with nicotine dust. The hoppers were put into the cage through the hole in the cover plugged with cotton.

(2) Front sheet-iron turned over showing nozzles. The nozzle ending in two forked flattened tubes dusts the lower surface of the leaves of two rows of beets. The nozzle ending in a funnel is provided with a sieve-plate which forces the dust between the petioles.

beet leafhoppers which were killed in screen wire cages with old dust preparations varied as follows:

Kaolin, Lime, "Black Leaf 40" 6%, killed 16%.
Kaolin, Lime, "Black Leaf 40" 8%, killed 75%.
Kaolin, Lime, "Black Leaf 40" 10%, killed 16%.

The dust mixture containing 10% "Black Leaf 40" was now applied to one acre of beets isolated by alfalfa fields and the percentage of beet leafhoppers that were killed was approximately determined. Another acre of beets was used as a check or control at a distance of about 1000 feet from the dusted field. The nearest beet fields were about a mile away from the two experimental areas. Before dusting, three men estimated the number of bugs present in different rows of beets in the two acres during the early morning. It was found that there was an average of 6 adults to 100 feet of a row of beets. After applying the dust at the rate of about 100 pounds to the acre, there was an average of 5 adults to 100 feet of a row of beets. The inefficiency of the dust was due to the fact that the lime was partly air-slaked and lost some of its active properties. Four days later another dust mixture containing freshly burnt lime was applied to the same acre of beets. Three days after dusting there were 4 adults and 1 nymph in 630 feet of beets or a reduction of 84% of the hoppers. In the acre used as a check, there were 6 adults and 9 nymphs to 100 feet of a row of beets.

The percentage of leafhoppers which were killed in screen wire cages with the newly made dust containing 10% "Black Leaf 40" and applied with a dusting machine at the rate of about 100 pounds to the acre varied as follows:

	Dead 7 hours.	Dead 24 hours.	Dead 48 hours.
	59%	84%	96%
	92%	95%	100%
	56%	72%	82%
Average	69%	83.3%	92.6%

No conclusions can be drawn as to the value of dust mixtures as a method of control for the beet leafhopper, due to the fact that the beets were planted after the invasion into the cultivated area had occurred. The spring brood flew into the beet fields near King City between April 25-30, 1921. The beet seed was planted on May 9 and germinated on May 26 in the dusted and check acres. The first application of dust was applied on June 20, and the second on June 24, after the hatching of the second brood nymphs had occurred. It is evident, however, that with a reduction of 84% of the hoppers in a dusted acre of beets, a marked decrease in the percentage of curly leaf would occur in isolated beet fields providing the dust is applied shortly after the spring flight of the adults into the cultivated area.

ACKNOWLEDGMENT

The writers wish to express their sincere thanks and appreciation to Mr. W. S. Suttie, who applied the dust with the dusting machine, and who showed a remarkable interest in the Eutettix problem and faithfulness in his work during the past three years.

DISTRIBUTIONAL AND ECOLOGICAL NOTES ON ANOPHELINE MOSQUITOES IN CALIFORNIA[1]

By WILLIAM B. HERMS,
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No doubt it will be readily conceded that a complete study of the detailed distribution of Californian anopheline mosquitoes or any other species is a matter of considerable proportions presenting many obstacles such as extensive area, extreme elevations, transportation difficulties, etc. In area alone California's 153,650 sq. mi. of territory represents the combined areas of Mississippi, Louisiana and Alabama, a mosquito survey of any one of which would represent a magnificent task. However, an attempt has been made to carry out a state wide mosquito survey in which a distance of 18,000 miles was covered by automobile alone, reaching every county in the state. Elevations were reached ranging from about 200 feet below sea level in the Imperial Valley to about 10,000 feet above sea level in Tuolumne County. A total of 690 mosquito collections were made consisting of 6650 mosquitoes of all kinds. It was found that there are three species of Anophelines in California, viz., — *A. occidentalis* D. & K. (the western form of *A. quadrimaculatus* Say), *A. punctipennis* Say and *A. pseudopunctipennis* Theobald. Although the survey was intended to be a malaria-mosquito survey, it was considered highly important to include all available species of mosquitoes in every collection in order to know the relative abundance of anophelines in any one locality.

For purposes of comparison and administration the state was divided into the following divisions; viz., Sacramento Valley Counties, San Joaquin Valley Counties, Sierra Counties (northern and middle), Plateau Counties (northern and middle), Coastal Counties (northern, middle and southern), and Southern California as given in detail in earlier papers.[2,3] Furthermore in developing the totals it was found

[1]Contribution from the Division of Entomology and Parasitology, College of Agriculture, University of California.

[2]Occurrence of malaria and Anopheline mosquitoes in Northern California. U.S. Public Health reports, Vol. 34, No. 29, pp. 1579-1587. July 18, 1919.

[3]Occurrence of malaria and Anopheline mosquitoes in Middle and Southern California. U. S. Public Health Reports, Vol. 35, No. 6, pp. 275-281, Feb. 6, 1920.

convenient to consolidate all the counties north of Tehachapi into two divisions, namely Northern California and Middle California, designating everything south of Tehachapi as Southern California.

Although this paper is not concerned with the occurrence and distribution of malaria in California it is nevertheless interesting and apropo as well to review the conclusions reached in the malaria-mosquito survey recently completed (See U. S. Public Health Reports Vol. 34, No. 29) viz:—

Comparing the average annual death rate per 100,000 of Northern California and Middle California it will be seen that the rate is almost the same, namely 4.9 for the former and 4.7 for the latter. Furthermore, the percentage of Anophelines taken in both divisions is not widely divergent, i.e., 38 per cent in the former and 31.1 per cent in the latter and of these *A. occidentalis* and *A. punctipennis* combined represented 77.9 per cent of the total Anophelines in the northern division and 56.9 per cent in the middle division, the remaining being *A. pseudopunctipennis*, believed to be negligible in its relation to malaria. This stands in rather striking contrast to the conditions in Southern California, where the average annual malaria death rate is only .9 per 100,000 population, and where 49.6 per cent of the mosquitoes collected were anopheline, of which however 69.3 per cent were *A. pseudopunctipennis*. It will, furthermore, be seen that the average number of mosquitoes per collection for these two divisions (northern and middle) was 9.9 for Northern California and 13.1 for Middle California, indicating a greater abundance of mosquitoes for the latter, but it is interesting to note that the relative number of *A. occidentalis* and *A. punctipennis* combined per collection was very similar, namely 3.6 for the northern area and 4.1 for the middle area, corresponding more or less closely in proportion to the malaria death rate, and that the average number of mosquitoes per collection for Southern California was 10.1, while the average number per collection of *A. occidentailis* and *A. punctipennis* combined was only 1.7 and the malaria death rate .9 per 100,000.

Although the San Joaquin Valley is commonly regarded as not greatly unlike the Sacramento Valley topographically, it will be seen that the annual malaria death rate for the latter is almost twice as high as the former, namely 6.3 per 100,000 for the San Joaquin and 10.9 for the Sacramento. It would appear that this high rate for the latter is explained by the high rate of effective Anopheline carriers, i.e. 46.6 per cent of all mosquitoes taken in the Sacramento Valley were *A. occidentalis* and *A. punctipennis* combined, and only 18.8 per cent consisted of these two species in the San Joaquin Valley.

While the two groups of Sierra counties, northern and middle, show an approximately equal malaria death rate, namely 9.1 for the former and 10.5 for the latter, there is much divergence in the anopheline mosquito population, as far as collections were made. Owing to a time limit in carrying on the survey during 1919, the middle Sierra counties were not as well covered as had been contemplated, and in the second place Mariposa County, herein included, represents a strong transition, both in faunal and topographic conditions, factors which are not easily overcome in a classification based on county lines. In spite of this there is, nevertheless a high percentage of *Anopheles punctipennis*.

The coastal counties, northern, middle and southern, show a much more consistent rate, both for malaria and for Anophelines, i.e. a very low malaria rate and a very high rate of *A. pseudopunctipennis*, the predominant Anopheline.

That the relation between potentially effective anopheline carriers alone and the malaria rate should not be pressed too hard is indicated by the fact that the combined *A. occidentalis* and *A. punctipennis* rate for the San Joaquin Valley stands at 18.8 per cent, with a malaria death rate of 6.3 per 100,000 population, as compared with Southern California with a rate of 15.2 per cent (*A. occidentalis* and *A. punctipennis* and a malaria death rate of only .9 per 100,000. In other words, if the potentially effective Anopheline rate alone were a sufficient indicator of malaria incidence, Southern California should have a much higher rate than it actually has. This seeming discrepancy is readily explained by the fact that the two areas in question are in reality not comparable, owing to divergent fundamental physical factors which control biological phenomena. For example, one often travels many miles and tries many times in the more arid part of Southern California before mosquitoes of any kind are encountered, and then they may be present in considerable numbers, i.e. they occur in isolated and widely separated spots. Thus, for example, after many miles of travel and careful search without success rather suddenly our party encountered enormous numbers of *Anopheles occidentalis* at a hot springs resort in Riverside County, in a district removed from centers of population. Again, many of the Anophelines (*A. occidentalis*) in this part of the state were taken in Ventura County, particularly near the city of Ventura, where the summer temperature is uniformly quite low, vitally influencing biological interrelationships. The occurrence of malaria is dependent upon a combination of factors in addition to the presence of potentially effective mosquito carriers, among them being temperature (both above and below a certain range), proximity of population to anopheline foci, a sufficient production of Anophelines, etc.

Anopheles occidentalis D. & K. in California occurs most commonly in the Sacramento and San Joaquin Valleys, practically throughout the former, and from within a very few miles of both the Oregon and Mexican boundaries, i. e. straight through the state North and South from Siskiyou to San Diego Counties. Except for the Sacramento Valley where infection is general and almost so for the San Joaquin this species was found to occur only in more or less isolated foci in other parts of its range. It was taken in great numbers within a few feet of the ocean in Ventura County where cool fogs generally prevail, and the temperature is consequently uniform, to an elevation of 5,480 feet in Sierra County where the summers are hot and the winters are cold. In general, however, the Sierra except the foothills are free from *Anopheles occidentalis*. The locality in Sierra County undoubtedly is the result of influences from the Northeast as are also the localities in Modoc and Lassen Counties. Ordinarily this species is abundant throughout its range.

Anopheles punctipennis Say on the other hand shows a distinct inclination to hug the Sierra foothills with sporadic foci in but very few other parts of the state. Only one collection of mosquitoes south of Tehachapi contained this species, namely a few specimens in one locality in San Diego County. Unlike either *A. occidentalis* or *A. pseudopunctipennis* this species is not noticeably abundant in numbers of individuals in any one locality.

Anopheles pseudopunctipennis Theobald has a very wide distribution in California, almost coinciding with *A. occidentalis*, though absent from the extreme northern tier of counties. This species is also very abundant everywhere that it occurs.

In addition to the collection of adults, larvae were taken and notes made relative to breeding habits. Field laboratories in connection with mosquito abatement districts and other special laboratories as well have been maintained in various parts of the state. Much data has thus been accumulated, of which little has as yet been correlated. That *A. occidentalis* breeds by preference in rather clear pools of water in which vegetation is fairly abundant and open to sunshine seems to be the case. *A. punctipennis* on the other hand apparently prefers quiet shady pools. *A. pseudopunctipennis* evidently breeds by preference in clear shallow pools along the edges of receding streams. All three species are partial to mats of spirogyra which provide a convenient shelter against natural enemies such as predaceous aquatic insects and surface feeding fishes.

During the summer of 1920, from May 12 to July 13, daily collections of mosquitoes were made at Vina (Northern Sacramento Valley), one

series being indoors and the other outdoors. The indoor collections were made regularly in the same buildings consisting of a cowshed, a washhouse, showerbath, storehouse and dwelling, while the outdoor collections were made under a short wooden bridge within ten to twelve feet of an aggregation of shacks occupied by chinese and negroes. The indoor series taken in an area where control measures were in progress does not represent a large number of mosquitoes but the fact remains that of seventy-seven anophelines taken, fifty were *Anopheles occidentalis* (including only one male) and twenty-seven were *A. punctipennis* (including two males) or practically twice as many of the former. On the other hand the outdoor series represented a total of 343 anophelines of which 102 were *A. occidentalis* (42 males and 60 females) and 241 were *A. punctipennis* (130 males and 111 females) or something over twice as many as the latter.

These collections bear out very well the general observations that *A. occidentalis* like *A. quadrimaculatus* is typically an invader of houses and consequently of greater importance as a malaria carrier, while *A. punctipennis* is chiefly an outdoor biter, porch biter, etc., and of less importance as a malaria carrier. During the entire period of two months the well screened cottage which was occupied by our party was not invaded a single time by *A. punctipennis* while *A. occidentalis* was a common visitor. Our experience with *A. pseudopunctipennis* during this period was so limited that no general deductions can be made, however, in our wide experience with this species in other parts of the state we are inclined to believe that it is a typical field species although it bites human beings very freely.

As may be seen from the above the number of males and females for the two species under consideration is not far from equal. In this connection it is interesting to note that the males disappear about the middle of November and reappear the following year during the last week in April. *A. occidentalis* winter over in the adult stage, the females often appearing in enormous numbers during the warmer days of February and March when egg laying begins. These observations are important from the standpoint of control and it has been consistently advised that mosquito control operations should begin in the autumn with a strong intensive campaign to clean out the last brood and again another early spring campaign to eliminate the first brood. Remarkable results have thus been accomplished.

THE SEASONAL HISTORY OF *ANOPHELES OCCIDENTALIS* D. & K. IN CALIFORNIA[1]

By STANLEY B. FREEBORN, *University of California*

The control of malarial mosquitoes has been operated for years on the assumption that Réaumur's classical work on the life history of *Culex pipiens* was a suitable basis for the life history of all mosquitoes. It is only within a comparatively few years that ecological studies have been conducted with anopheline mosquitoes to lay the foundation for a more economical and efficient method of control operation than that which followed the old slogan of "Oil or drain all standing water" with no reference to type of breeding place, presence of larvae, or time of year. There is no question in the writer's mind regarding the *success* of a campaign carried out along these lines, but in the light of what we know regarding selective breeding and the limited generations of the insects, the waste in materials, time, and energy of these "shotgun" methods is appalling.

Perhaps the most important field for improvement can be based on the study of the life history. It was the writer's good fortune to be detailed to co-operate in June 1919 with a party of U. S. Public Health Service officers at Chico, California where investigations were being carried on regarding the status of anopheline mosquitoes in the rice fields. In this month he began a weekly collection of all mosquitoes appearing under a highway bridge situated some distance from the nearest rice field. This procedure was maintained by the writer until other work called him away in August after which Mr. W. C. Purdy, special expert of the U. S. P. H. S., made the weekly collections forwarding them to the writer for identification. The bridge under which the collections were made was a modern, concrete, highway structure spanning a natural drainage slough, continually holding water but without a noticeable current in the immediate vicinity of the bridge during most of the year. Mosquito breeding, during the season, was prolific in many parts of the slough. No control measures were undertaken within five miles of the bridge. Collections were made in shell vials containing chloroform or cyanide, the specimens transferred to pill boxes and transported to the laboratory for identification. All mosquitoes resting on the roof or sides of the bridge were taken except on certain occasions when the single collection would have run into the thousands. At such times the distribution of the mosquitoes under the bridge was observed and enough sections

[1]Contribution from the Division of Entomology and Parasitology, Univ. of California, College of Agriculture.

covered to approximate a half or a quarter, from the identification of which the whole population was estimated. In all, 26,010 mosquitoes were collected and identified in the sixteen months of the project, of which 5,756 were *A. occidentalis* D. & K. Because this species found its optimum breeding conditions in the immediate vicinity of the collection point and its more important bearing upon the malaria question, for as

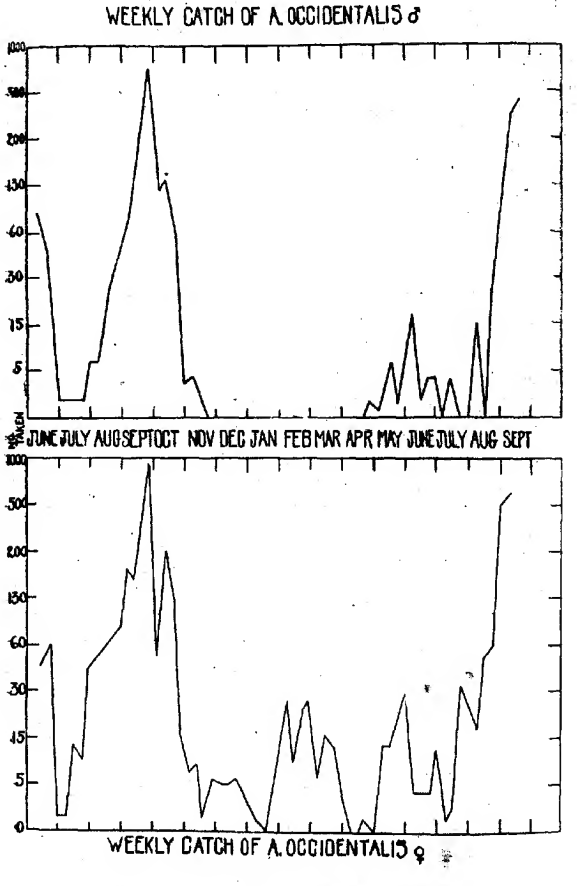

Fig. 9. Seaonal Occurence of *A. occidentalis*

the western counterpart of the eastern *quadrimaculatus* Say it is undoubtedly the most important malaria carrier in the West, the above explanation and charts are offered.

The study of the chart of male collection establishes two points (1) that hibernation, indicated by the absence of males starts just after the middle of November and (2) the curves are strongly suggestive of only two generations a year with a possibility of the earliest members of a third overtaking the stragglers of a second during September with the appearance of a possible fourth in October or November. In connection with the first point, "hibernation" is used in a rather loose fashion as no true dormancy occurs in the overwintering females. They frequently change their places of refuge as shown by the fact that we were able to make repeated complete collections beneath the bridge thruout the winter. However, they show no inclination to feed in the open thruout the period, the earliest records of this being in January in unusually warm weather.

In February of each year the females begin to emerge from their overwintering refuges. In the year shown on the chart (1920) this emergence was accomplished gradually, but on the following year the emergence was extremely uniform and striking. About February twentieth communities in many parts of California were deluged with enormous swarms of *A. occidentalis* females which invaded houses, biting viciously even in bright sunlight. By the last of the month, however, they had practically disappeared. During this flight of emergence, the area infested is almost always greater than at any other period of the year, many districts being invaded in February by *A. occidentalis* that are entirely free from them during the remainder of the year. The only explanation at hand is that the unusual length of flight at this time is a biological stimulus to ensure the spread of the species. Females dissected during the winter and at the start of the emergence flight contained round, half grown eggs in the ovaries but those taken later showed fully developed eggs. Some unfed migrants given a blood meal in the laboratory developed mature eggs in approximately 48 hours. This migratory flight from hibernation quarters on the part of the overwintering females is the official opening of the season for *A. occidentalis* Eggs are deposited and the adult population falls off very rapidly in numbers with adult mosquitoes practically absent in April. From the information at hand, which is limited to a single experiment and the study of the chart of female *occidentalis* collections, it would appear that the overwintering females lay but a single batch of eggs before death overtakes them. Several migrant females were confined in the laboratory in the spring of 1920, and given blood meals whenever they could be

induced to bite. All deposited single batches of eggs and then died despite the utmost care without ovipositing a second time in contrast to the midseason females which frequently deposit two and sometimes three batches of eggs in captivity under similar circumstances. The study of the collection chart of both males and females shows the emergence of the first generation of the year reaching its peak during the first of June and is followed by a rapid decrease in numbers that would have been replaced by a more sustained curve had there been more than one series of deposited eggs. It is interesting to note the three peaks that denote the emergence of first brood males in April, May and early June and hazard at their connection with the three peaks of overwintering females that were abroad in February and March (the emergence from hibernation being unusually gradual during the year in question.)

The individuals of this first generation which began to emerge from pupation in May and June are relatively few in number. This may be due to the small number of eggs deposited by the overwintering females as advanced above, or it may be due to the hazards of life at this time of year. The average low temperature prolongs the larval life of this generation to approximately two months during which time they are constantly exposed to their predaceous and parasitic enemies and to the danger of being washed out by high water, a factor which disposes of many mosquito larvae breeding along the edges of streams fed by melting mountain snows.

Fertilization of the females takes place immediately upon emergence. The males emerge first and may be seen hovering over or near the breeding places in small swarms awaiting the appearance of the females. The universal fertility of captured wild specimens points to a very perfect biological arrangement enabling an infallible fertilization of the female and strengthens Knab's conclusion based on his observation of anopheline mating that the female seeks out a male from the hovering swarm.

The egg deposition of this first generation begins within a few days of its emergence. The average number of eggs deposited in a single laying by *A. occidentalis* is according to Herms and Freeborn, approximately 200 eggs, a much greater number than had previously been supposed. The number of layings can not be estimated with our present technique. The two biological factors that have hindered us in this work are (1) inability to produce copulation with bred specimens in captivity which forced the use of wild material regarding whose previous egg deposition we had no check and (2) inability to keep laying females alive in captivity until their ovaries no longer showed the reappearance of a new batch of eggs following the deposition of the second and on one occasion a third laying. Every attempt was made to reproduce natural conditions in

respect to temperature, humidity, breeding places, and food but death always resulted with one exception before the third deposition and subsequent dissection invariably showed the ovaries filled with eggs which from a biological standpoint would indicate a premature death. The total number of eggs that can be deposited by a single female of this first generation under natural conditions must remain a conjecture at this time. Under laboratory conditions the greatest number of separate layings for *A. occidentalis* was three, with a total deposition of four hundred and ninety-one eggs.

With this propensity for egg laying in mind which under natural conditions is continued thru an unknown number of batches, the ascending curve beginning in late July and reaching its peak in late September is easily foreseen.

The origin of the overwintering females is a difficult point to fix. However, Mitzmain has shown that engorged females are unable to pass the winter successfully. It is to be inferred therefore, that they are the members of the last batch of the season which occurs if we refer to the chart of male collections and estimate the life of the male *occidentalis* at a week, about the fifteenth of November. Whether these individuals are technically stragglers of the second generation represented by the September peak or of a third or fourth generation is at present unknown.

The practical points from a control standpoint in these studies resolve themselves about the time for offensive measures against malarial mosquitoes. After the migratory flight of the overwintering females there follows a rapid decrease in the adult population to the point when practically every living member of the species is in the aquatic larval stage, (early April in the locality represented in the charts.) The drainage, filling or oiling of all breeding places at this period, if carefully done controls, with the exception of the subsequent breeding of foreign invading females, the entire generation that are the progenitors of the summer and fall broods. If this opportunity is neglected, the emerging females capable of depositing many consecutive batches of eggs lay the foundation for an overlapping series of adults and larvae that ensure the survival of the species over a continued campaign directed against the larvae.

Once again during the year man is given his chance to strike a decisive blow against this species. This opportunity comes in California in October or in any locality where hibernation occurs soon after the fall peak of the adult population takes place. At this time, the number of adults are being rapidly depleted but breeding waters are stocked with larvae which will give rise to thousands of females emerging too late to

feed and consequently fitted to overwinter and produce the eggs for the first generation of the next year. Control work pursued as the adults of the fall peak are decreasing and directed against the larvae invariably reduces to the minimum the numbers of overwintering females.

The practicability of these measures is not limited to a theoretical examination of the charts but has been demonstrated in actual field practice in California. In the fall of 1919, the writer had charge of an anti-malarial campaign at Anderson in Northern California, where preliminary work was undertaken in August. By October first, as far as repeated field inspections could determine, control was absolute. The work was continued on permanent ditches until December first during which time no larvae were observed. Work was then discontinued by our project, the responsibilities being assumed by local authorities. On the following spring at the time of the migratory emergence flight in surrounding areas, Anderson was comparatively free, a few adults drifting in from unprotected areas with the result that the individuals of the first brood even if uncontrolled would have been of little sanitary importance.

In the spring of 1921, the abrupt and overwhelming migratory emergence flight so incensed an already educated municipal population in the northern part of California that public clamor demanded immediate action on the part of the health authorities who responded by draining and oiling all breeding places in the municipality, hitherto a notorious malaria center. The first brood never emerged, and by midsummer mosquito control operations were discontinued as no larvae could be found within the area. On previous years when work was started at a later date the entire appropriation for mosquito control was invariably exhausted before the season drew to a close and mosquito control was problematical. This year, however, with work starting at a very early date mosquito control was absolute by midsummer and fully one-half the appropriation which was the same as on previous years, remained in the city treasury.

As *A. punctipennis* Say and *A. pseudopuncipennis* Theobald did not breed in the immediate vicinity of the collection point, the discussion is limited to *A. occidentalis* D. & K. Of these two species above mentioned, little is known concerning their hibernation in California. No records of adult capture during the winter months are at hand nor have their larvae been taken during this period[2]. Control measures directed against *A. occidentalis* as outlined above would control these species as well should they be shown to winter over as larvae.

[2]Mitzmain has observed overwintering females of *A. punctipennis* in Mississippi.

An interesting feature in the study of these collection data is to be found in a comparison of the first season (1919) with the second season (1920). During 1919 the nearest rice field was some distance away but during the intervening winter the entire area surrounding the bridge was leveled for rice and the collections for 1920 therefore show the rate to be expected from rice fields in that particular vicinity. The writer does not care to comment on this phase of the problem as Mr. W. C. Purdy of the U. S. Public Health Service, who so kindly made the collections upon which these studies are based, already has in preparation a report of this phase of the work which will undoubtedly be published at an early date by his service.

SUMMARY

1. Efficient mosquito-malaria control depends on an intimate knowledge of the life history of the mosquito in question and can not be based on the known life history of another species.

2. In California *A. occidentalis* D. & K. overwinters as an adult female, hibernation beginning about November 15th and terminating in February in a widespread migratory flight.

3. These overwintering females evidently lay but few eggs and have all disappeared by April at which time all the individuals of the species exist as larval forms.

4. The first brood of the year reaches its peak in June. The individuals of this brood have the ability to lay many series of eggs which accounts for the accumulative peak of mosquito population that occurs in September.

5. The species apparently passes thru two generations in a season with the possibility of a third or fourth under the most favorable circumstances.

6. Control work directed against the larvae after the spring migratory flight of overwintering adults and again after the peak is reached in the fall, if carefully done, will hold this species under control.

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ANURAPHIS HELICHRYSI KALT., A PEST OF PRUNE, PLUM, AND RED CLOVER IN IDAHO

By RALPH H. SMITH, *Entomologist,*
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Anuraphis helichrysi Kalt. is the most important plant louse affecting prune and plum in Idaho. Injury has been common in both domestic and commercial orchards during the past four years. Red clover and garden asters, the most important summer host plants, are frequently very heavily infested. Injury to clover during the summer of 1921 caused a marked reduction in the yield of seed in several fields near Twin Falls while florists and housewives have experienced real difficulty in successfully growing garden asters on account of this aphid.

HISTORICAL. The species first came to the attention of the writer in the spring of 1918 when on taking up work in Southern Idaho he found the foliage of prune, plum and peach to be infested with aphids to such extent that the leaves of many trees either mostly fell off or remained strongly curled thruout the summer. The aphid affecting peach was identified as *Myzus persicae* Sulz. The species infesting prune and plum was identified by Dr. C. P. Gillette and later by Dr. A. C. Baker as *Anuraphis helichrysi* Kaltenbach.

The pest doubtless has been present in Idaho for many years. Edmundson[1] does not mention it among the orchard insects of Idaho but we are led to believe that he and probably others have confused it with *Anurpahis cardui* L. (*A. pruni* Koch) which ranks next to *A. helichrysi* as an aphid pest of plum, at least in the southern part of the state. We have been able to find only two collections of aphids from prune and plum that were made in Idaho previous to 1918. One of these is a yet undetermined species collected in 1910; the other, which is labeled merely "*Aphis pruni* on prune, collected 1911", is *Anuraphis helichrysi* Kalt.

SEASONAL BEHAVIOR. Migrant females and males begin developing on the summer host plants during the latter part of August at Twin Falls (alt. 3700 ft.). They are found in fair abundance on foliage of prune and plum by the 15th of September. The migrants and greenish to reddish-brown oviparia feed preferably on the under surface of the leaves and especially within the closely curled leaves that have been curled by the spring generations. Eggs are deposited at the bases of buds and on the bark of branches. Hatching takes place very early while the buds of prune

[1]Insect Pests of the Orchards and Gardens of Idaho and their Control. Idaho Exp. Sta. Bul. 87, 1916.

and most varieties of plum are apparently entirely dormant and those of peach are only slightly swollen. The stem mothers which at firts are dark green but become distinctly reddish with a brown band on the dorsum of each body segment at maturity, feed at the bases of buds and thru the bark of the last season's growth until the fruit buds begin to open. The stem mothers begin reproducing about the time green tips appear on the fruit buds of prune. Migrants occur chiefly in the third and succeeding generations. The progeny of the stem mothers are pale green with the body integument semi-translucent; only the distal ends of the antennae and the tarsi show slightly dusky. In some instances plum trees have remained heavily infested thruout the summer.

CHARACTER OF INJURY. The aphid is strictly leaf-feeding on prune and plum but on red clover and other summer host plants it feeds chiefly on the more concealed parts of stems, petioles and blossoms. Infested leaves of prune and plum curl tightly and develop numerous pocket-like galls. New leaves at the tips of infested branches become curled as soon as they start to develop. The new growth of such branches is somewhat stunted and malformed and there appears to be a tendency toward premature dropping of the fruit as a result of the infestation of the foliage. Infestation is usually confined to one or a few branches on moderately affected trees, the aphids not spreading readily from one part of a tree to another.

HOST PLANTS. All varieties of prune and plum that have come under our observation have been susceptible to attack though seedlings and root sprouts appear to be favored. Occasional colonies have been found on peach and apricot in early spring but these did not thrive in the same vigorous manner as did colonies on Italian and Hungarian prunes, and varieties of plum. The most favored summer host plants in Idaho as determined at present are *Trifolium pratense* L., garden varieties of *Aster* sp., *Chrysanthemum* sp., *Dahlia* sp., and *Erigeron canadensis* L. The aphid has been observed in smaller numbers on *Achillea millifolium* L. *Solidago serotina* Ait., *Trifolium hybridum* L., *T.repens* L., and *Solidago* spp.

CONTROL MEASURES. Black Leaf 40 used at the rate of ¾ pint to 100 gallons of water with soap as a spreader or to 100 gallons of dilute lime-sulfur solution, and applied just before the buds open on prune and plum has given perfect control. Lime-sulfur at winter strength has not been effective in destroying either the eggs or the young stem mothers. Control of the pest in red clover fields is somewhat complicated and is discussed in detail in a bulletin on the Clover Aphis (*Anuraphis bakeri* Cowen) now in course of publication by the Idaho Experiment Station.

THRIPS INJURY TO PEACHES IN SOUTHERN CALIFORNIA

By GEO. P. WELDON, *Pomologist,*
Chaffey Junior College of Agriculture, Ontario, Calif.

In the fall of 1914 some Elberta peaches were received at the office of the State Commissioner of Horticulture, Sacramento, from Placer County. These peaches showed a type of injury which at that time was not recognized as being due to insects. A number of growers in the vicinity of Auburn and New Castle were complaining of damaged peaches which were noticed at the time the fruit was being packed. It was not until the next season that this injury was found to be due to the attack of some species of thrips. County Farm Advisor E. O. Amundson, in examining the blossoms of peaches early in the spring of the year, found that they were full of thrips. He later made observations which showed conclusively that the injury which had been observed commonly the previous season was due to this little insect.

No data is at hand which would enable one to make an estimate of the injury which was done during the years 1914 and 1915 in Placer County, however, it is known that in some sections severe damage resulted from the attack of this insect.

In August of 1919 the writer moved to Southern California taking up work with the Chaffey Junior College of Agriculture. It was found in looking over peaches that were coming into local canneries at Ontario that quite a large percentage of them showed injury similar to that which had been noted in Placer County. Estimates were made of the percentage of fruit which had the distinct marks of thrips and it was decided that at least twenty-five percent of all the fruit which was handled by two large local canneries showed marked infestation. Most of the growers and men associated with the canneries were undecided as to what had caused the injury. A few of the older growers however, recognized the fact that thrips were responsible for this injury as from time to time in past years they had suffered losses from it.

In 1920 the writer had an opportunity to make more extensive observations than previously; these during a year when the pest was worse than it had ever been known in the history of peach growing in Southern California. The loss, while it could not be estimated accurately during this season, would represent a large sum of money. It was estimated by careful observations in the field and of the fruit as it came into the canneries that more than fifty percent showed injury

from thrips. While this injury does not render the peaches valueless, many of them are culls that must be canned as very low grade fruit, while none of them can be packed in the higher grades.

Life History

While it was not possible to make careful enough life history studies of the pest to enable one to conclude definitely as to where it spends the winter season, etc., it was found that as soon as the peaches began to bloom in the spring adult thrips immediately got into the blossom where egg laying took place and where feeding was done by both adults and larvae.

Throughout the time of blooming of the peaches and later until the time when the husk shed from the little peach the injury continued. Practically no injury was done after the shedding of the husk. The very uneven blooming season during 1920 made it difficult to get any results whatsoever with a contact spray. Various things were tried but with no success as will be indicated later. The blooming period lasted approximately two to three months, according to the variety and all this time as the trees were coming into bloom, thrips were going into the blossoms.

After the peaches had attained considerable size many thrips were found in the tender growth at the tips of the twigs. In fact, throughout the entire summer season some of them could be found in such places but none on the fruit for any length of time after the shedding of the husk. The injury therefore, by this species, was found to be done while the trees were in bloom and afterwards up to the time of the shedding of the husks.

Demonstrations

A series of demonstrations were planned during the season of 1920 which were designed to give the growers an idea as to how the pest might be controlled. It had been claimed by those who had worked on the pest in Placer County that a thorough spraying while the peaches were in bloom, or a little later, with Nicotine Sulfate Distillate Emulsion mixture which is so successfully used in pear thrips control, would bring results. After one or two demonstrations had been conducted it was determined that so small a percentage of the thrips was being killed that the spraying was not paying for itself. Careful observations of the insect in treated blossoms led to the belief that not over fifty percent were killed by a single application of the Nicotine Sulfate Distillate Emulsion mixture. It must not be understood from this that the mixture did not kill for it was found that where it was

possible to get the spray on the thrips, that there was no trouble in killing them. The difficulty lay in being able to get the spray into the blossoms and later under the husks of the little peaches.

Various types of nozzle were used and as high pressure as was possible to obtain with a power sprayer was tried in an effort to get the spray where the thrips were protected by the blossoms or the husks. In all the work the fact was apparent that the protection of the stamen bars and the pistil of the peach blossom was such that it was almost impossible to reach the insects with the spray and after the peaches had formed the same difficulty was experienced in getting the spray beneath the dried-up blossom or husk. Thus, after recommendations had been made regarding the way this insect might be controlled, spraying was stopped in orchards of the community because of failure to get the desired results.

Dusting

Samples of Nicodust manufactured by the California Walnut Growers Exchange were also used in some experiments. Regular strength of this material as well as double strength; also a Nicodust material made from nicotine and sulphur, were all tried but none of them were successful. Blossoms that were thoroughly coated with these dust materials were brought into the laboratory and in twenty-four hours' time it was found that the thrips were apparently just as lively as before the material was applied. A few thrips seemed to be killed where the dust came in actual contact with them but where it did not, there seemed to be no effect from fumes and thrips inside of blossoms where the stamen bars and pistil were heavily coated with this material were as lively as ever.

In 1921 the dusting experiments were repeated although it was not possible during this season to find as bad an infestation as most of the orchards had the previous season. The same negative results were secured in 1921 as in 1920.

Injury

The characteristic injury done to peaches by thrips assumes a number of different forms which seem to be influenced somewhat by the variety.

In the case of Phillips Cling variety for example, a very common type of injury is a little conical shaped swelling on the surface of the fruit. In the case of the Tuskena variety the injury that is more commonly noticed consists of a pitting or dimpling of the surface of the fruit. In other cases where the fuzz has been removed entirely by the thrips in feeding, the skin will be colored a deep red and will be smooth like the

skin of the nectarine. Wavy red lines are commonly seen on such varieties as Lovell, while russet or scabby patches and streaks may be found on practically all varieties where injury has taken place.

This injury, while as has already been stated, does not seriously impair the quality of the peach, makes it very difficult to remove the peel when the fruit is being canned. In the modern commercial canneries the peaches are peeled by means of lye and it was found that the lye bath did not successfully remove the skin from thrips injured peaches, thus necessitating hand trimming of the portions of the fruit affected, which is slow and expensive.

Other Hosts

Not only is the species of thrips which is found injuring peaches injurious to this fruit, but it is also very commonly found on plums, apricots and nectarines. In the case of the nectarine the injury is more severe than with any other fruit where the pest has been seen. Plums are frequently badly injured while apricots are injured to a lesser extent. The Royal variety which is more commonly grown in California than any other variety of apricot, does not seem to be so susceptible to attack as the Tilton variety, another commercial sort which is commonly grown. Wherever the latter variety has been observed, large numbers of thrips. have been found feeding upon it.

A species that may be identical with the peach species has been found feeding on apples in the Yucaipa section of San Bernardino County. During the season of 1920 there were large numbers of thrips in the blossoms of the apple but the injury did not seem to be great.

Seasonal Occurrences

Fortunately the thrips pest seems to vary greatly in its attack from season to season. As has already been stated during the season of 1919 and 1920 the injury in the Ontario-Cucamonga-Pomona section of Southern California, was very severe. This year, 1921, the injury was slight and in the spring it was rather difficult to find orchards where there were enough thrips to make experimental work worth while. Then too, the blooming season of peaches in 1921 extended over a much shorter period than the previous season. This factor in itself bears a very close relation to the damage done by the insect for when there is a long blooming period there *is* a correspondingly long time for the insects tofeed in the blossom and under the husks which of course, means far greater injury. While the blooming season in 1920 as has been stated, was from two to three months, in 1921 peaches were through blooming in practically one month's time.

Species

Nothing has been said that would indicate what species of thrips is responsible for the injury to peaches that has been described in this paper. At the present time a positive determination has not been made. The species very closely resembles the grain thrips, *Euthrips tritici* but some thrips experts who have examined material doubt that it is this species. There is a possibility of its being *Euthrips helianthi* according to Morgan of the U. S. Bureau of Entomology. Paul Jones, Entomologist for Balfour, Guthrie & Company, San Francisco, who has examined material, thinks that the species is *Euthrips tritici*, although he is not positive that it is. The writer inclines to the belief that *Euthrips helianthi* is the species which we have been dealing with in our peach orchards. It is a species that is very commonly found on sunflowers and last fall in fields where there were hundreds of acres of sunflowers in bloom, thrips occurred in large numbers in every blossom. It however, seems to be a general feeder and may be found in the blossom of alfalfa, Burr clover, Melilotus, mustard, and various other flowering plants.

The great damage which has been done during certain seasons by this species in both the Northern part of the state and the Southern deciduous fruit growing section, makes it a pest of first importance. The injury to peaches as it occurred in 1920 in the Ontario section is comparable to that of pears by pear thrips during a season of bad infestation. It is therefore important that some careful work be done on this insect to determine the species, its life habits and methods of control. At the present time we are not justified in stating that the ordinary methods which are used in the control of pear thrips will be a success in the control of peach thrips because the pest is so well protected during the entire time of its feeding on peaches.

THE RESULTS OF USING CERTAIN OIL SPRAYS FOR THE CONTROL OF THE FRUIT TREE LEAF-ROLLER[1] IN THE PAJARO VALLEY, CALIFORNIA

By Donald D. Penny, *Watsonville, Calif.*

The fruit tree leaf-roller, in the Watsonville[2] apple district, continues each season to damage a certain amount of the fruit crop and while the infestation has never become such a serious menace as has been reported from some sections of the West, this insect does, however, do enough injury to render it a pest worthy of considerable attention.

[1] *Archips argyrospila* Walker.

[2] The city of Watsonville, California, is located on the coast about one hundred miles south of San Francisco, in the center of the Pajaro Valley. This valley contains approximately nineteen thousand acres of bearing apple orchards.

Oil spraying for leaf-roller control in the apple orchards of the Pajaro Valley during the past few years has been, at best, only partially successful. The more or less unsatisfactory results obtained were undoubtedly due to several factors, one of which, and in the writer's opinion, by far the most important, has been the use of oils not especially adapted to leaf-roller control.

Various workers along these lines have recommended, at different times, kerosene emulsion and miscible oil sprays. Indeed the splendid results obtained by Gillette and Weldon[3] in Colorado, by Leroy Childs[4] in Oregon and by B. B. Fulton[5] in Oregon would seem to indicate that the problem of leaf-roller control has been solved. In the Watsonville section, however, oil sprays that might be classified under the names of kerosene emulsion or miscible oils have given practically no control. It occured to the writer that the generally negative results obtained with these types of materials might possibly be due to the fact that the oils used may have been of the Western, or asphaltum, type rather than the Eastern or paraffin type. Mr. George M. List[6] in reporting the results of the season's spraying in the Canyon City and Penrose districts of Colorado in 1919 states that a considerable difference was found between the killing qualities of a miscible oil prepared from a heavy paraffin base oil and a miscible oil prepared from an asphaltum base oil. With the idea of this difference in mind several tests of a few samples of both of these oils were conducted by the writer during the winter of 1920-1921 and it is with the results of these experiments that this paper chiefly deals.

The several oils used in the tests included a 42° Baumé crude oil direct from the wells of Pennsylvania, Gas oil, a distillate of 34° Baumé from the Pennsylvania crude oil and sold by the Standard Oil Company of New Jersey, a 24° Baumé California crude oil, Western Shell distillate of 38° Baumé, Calol Diesiel engine oil of 24° Baumé sold by the Standard Oil Company of California. In addition to these oils two commercially prepared emulsions were tested. These were Ortho Crude Oil Emulsion manufactured by the California Spray Chemical Company and Spramulsion sold by the Sherwin-Williams Company. Also included in the

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[3]Gillette, C. P. and Weldon, Geo. P. 1912. The Fruit Tree Leaf-Roller in Colorado. Circular 5. Office of State Entomologist of Colorado. October 1912.

[4]Childs, Leroy. Entomological Investigations 1915. Report of the Hood River Branch for 1914-1915. Oregon Agricultural Experiment Station.

[5]Fulton, B. B., 1921. The Fruit Tree Leaf-Roller. Report on Progress of Investigations. Third Crop Pest and Horticultural Report, 1915-1920. Oregon Agricultural College Experiment Station, Jan. 1921.

[6]List, Geo. M., 1920. Fruit Tree Leaf-Roller, Archips argyrospila Walker. Circular 28. Eleventh Annual Report of the State Entomologist of Colorado for the year 1919-Aug. 1920.

table of results is a count from egg masses collected from an orchard sprayed in January 1919 with Miscible Oil No. 1, manufactured by Balfour Guthrie & Company. In regard to this latter test, however, the writer desires to explain that he cannot vouch for the quality of the work as it was purely a commercial job and was in no way under his direction nor was he present to witness any of the operation of spraying.

The writer's experiments, which for the most part were similar to those conducted by other workers along these lines, included the dipping of egg masses in various emulsions as well as the actual spraying in the field.

By referring to the accompaning tables the data obtained in counting the egg masses may be noted. The (a) figures represent the results of the kill obtained by dipping egg masses in emulsions and then incubating the eggs at about 27°C. Before placing the eggs in the incubator they were left exposed to the air for a period of fourteen days. The reason for dipping egg masses in the emulsions was to obtain thorough contact between the mass and the liquid, a factor which cannot be entirely controlled in actual spraying. Dipping also affords a simplified method of indicating, to a limited extent, the effects of the various strengths of the oils used.

The (b) figures represent the egg counts from the sprayed plots.

All of the emulsions prepared for the experiments contained 2.5% of cresol soap as the emulsifying agent, with the exception of one sample of the Pennsylvania crude oil which was emulsified by the California Spray Chemical Company using the same method that is employed in preparing the regular Ortho Crude Oil Emulsion. The cresol soap was prepared according to the following formula: creselic acid 5 pounds, fatty acid 5 pounds, sodium hydroxide 1.7 pounds.

The figures obtained from the Western Shell distillate plot serve very well for a check as the count from the actual check plot varied but little from these figures. In obtaining the counts from the eggs on the trees the method followed was to tag a number of egg masses on the trees of each plot just after spraying and to refer to these masses for the count when the hatch for the district was complete. This tagging prevented including egg masses that may have remained on the trees from the years previous. In each case when one or more eggs hatched in the mass it was considered as a hatch for the mass.

In arriving at the percentage of kill for the various oils a more accurate figure would obviously have been obtained if a greater number of egg masses had been used for the counts. However, in order to facilitate the work, this higher degree of accuracy was sacrificed for the reason that the total number of egg masses in any infestation in this district is relative-

ly small and consequently the eggs are very difficult to obtain in large numbers. The eggs are placed almost entirely on the extremities of the branches, on twigs usually not greater in diameter than an ordinary pencil. The writer has never observed an egg mass on the main trunks of trees in the Watsonville district and it is indeed rarely that the eggs can be found even on large branches. It is quite evident also that this position factor of the eggs has a direct bearing on the degree of killing efficiency that can be obtained, even with a well adapted material, because of the misses that unavoidably occur in spraying. Within the bounds of economy it is almost an impossibility to thoroughly wet the extremities, particularly if the trees be large. It might be added further that the comparatively small number of eggs deposited means a small number of worms, each of which is able to do its maximum amount of injury and any spray that tends to reduce the number of worms at all will correspondingly reduce the total amount of injury.

The best control obtained with any oils in the tests was procured with the emulsion of the Pennsylvania Gas Oil, 10 per cent of which gave an 80.9 per cent kill in the sprayed plot.

The results obtained by dipping eggs in three strengths of this same oil would seem to indicate that for spraying a 5 per cent dilution is a little too weak while a 15 per cent strength would possibly give a better kill on the trees than 10 per cent. It is the writer's opinion in this case, however, that a 10 per cent emulsion is sufficiently strong and that inefficiency in spraying accounts for the 19.1 per cent of eggs that were not killed.

The Pennsylvania crude oil in both types of emulsions gave very good killing results with the dipped masses in the 10 per cent and 15 per cent strengths. The same can be said of the Calol Diesiel Oil. The failure of the 10 per cent strength of these oils to kill the eggs on the trees is not easily explained, especially since the same strength in dipping was quite effective with all of them.

The emulsions of California distillate gave practically no control with any strength, the figures being about the same as the check for both dipped and sprayed egg masses.

The results obtained with Spra-mulsion on the trees were almost negligible and only fair results were obtained with the dipped masses.

The count of the eggs from the orchard sprayed with the Balfour Guthrie & Company's Miscible Oil No. 1 showed a very low percentage of kill, but as stated before, the writer is in no way responsible for the preparation or application of the spray in this orchard.

The Ortho brand of Western crude oil emulsion gave a 50 per cent kill on the trees sprayed with the customary 12 per cent strength of oil. The results obtained from both types of emulsions of the Western crude oil in the dipping experiments gave some rather interesting figures showing that the killing efficiency varied more or less directly with the percentage of oil in the mixtures. In regard to the figure of 97.7 per cent kill obtained with the 15 per cent Ortho crude oil sample it might be explained that all but one egg in one mass failed to hatch which would make the actual kill very close to 100 per cent. The results obtained with the 12 per cent crude oil sample on the trees were not entirely satisfactory, in spite of the fact that the number of cull apples was reduced to 9.92 per cent total injury as compared with a check of 26.9 per cent total fruit injury. The figures obtained from the masses dipped in 15 per cent strength would seem to indicate that this greater strength of oil is needed to obtain satisfactory results from spraying, especially since under the ideal killing conditions offered by the dipping method the strength of oil required was 15 per cent for good results. This is a point which will be carefully investigated during the coming season.

Crude oil emulsions are widely used in the apple orchards of the Pajaro Valley as general winter sprays, giving excellent results in the control of the many scale insects as well as numerous other resistant overwintering insect forms. In addition, these materials produce marked tree stimulation. For these reasons the continued use of crude oil emulsion is highly desirable on the part of many growers and it would undoubtedly become even more so if found effective in controlling leaf-rollers at a strength within the limits of reasonable costs.

	Strength	Date	Unhatched	Hatched	Total	Kill
(a)	5% Western crude oil-(Ortho)		22	29	51	43.1%
	10% " " "		31	14	45	68.8%
	15% " " "		44	1	45	97.7%
	Check		1	51	52	1.9%
(b)	12% Western crude oil-(Ortho)	Feb. 3	30	30	60	50.0%
(a)	5% Penn. crude oil (emulsified the same as Ortho)		45	2	47	95.7%
	10% Penn. crude oil		46	0	46	100.0%
	15% " " "		48	0	48	100.0%
(b)	12% " " "	Jan. 11	10	17	27	37.0%
(a)	5% Western crude oil		26	26	52	50.0%
	10% " " "		38	5	43	88.3%
	15% " " "		42	1	43	97.6%
	Check with 5% cresol soap		6	38	44	13.6%
(b)	10% Western crude oil	—	—	—	—	—
(a)	5% Penn. crude oil		34	17	51	66.6%
	10% " " "		40	0	40	100.0%
	15% " " "		48	0	48	100.0%
(b)	10% " " "	Feb. 3	14	38	52	26.9%
(a)	5% Western Shell distillate		7	44	51	13.7%
	10% " " "		9	38	47	19.1%
	15% " " "		6	43	49	12.2%
(b)	10% " " "	Feb. 3	1	56	57	1.7%

(a)	5% Penn. Gas Oil		41	3	44	93.1%
	10% " " "		44	0	44	100.0%
	15% " " "		51	0	51	100.0%
(b)	10%	Feb. 3	51	12	63	80.9%
(a)	5% Calol Diesiel Oil-Standard Oil Co.		24	22	46	52.1%
	10% " " " " " "		50	3	53	94.3%
	15% " " " " " "		52	0	52	100.0%
(b)	10% " " " " " "	Feb. 8	19	48	67	28.3%
(a)	Spra-mulsion maximum strength recommended 1–10		25	19	44	56.8%
(b)	Spra-mulsion maximum strength	Feb. 8	6	44	50	12.0%
(b)	Miscible Oil No. 1 Recommended strength (Balfour Guthrie & Co)	Jan. 1919	4	53	57	7.01%

SUMMARY OF LIFE HISTORY OF BEET LEAFHOPPER (EUTETTIX TENELLA BAKER)

By HENRY H. P. SEVERIN, Ph. D.,

California Agricultural Experiment Station.

According to Ball[1] the beet leafhopper (*Eutettix tenella* Baker) is a "single-brooded species." In his life history chart, Ball indicates that the adults make their appearance on beets in March and the nymphs are present from May to July in the San Joaquin Valley and from May to August in the Salinas Valley of California.

We[2,3] have published an account of the life history of the beet leafhopper and reared two broods out-of-doors in the fog belt district at Berkeley during 1918.

Stahl[4] bred two generations out-of-doors in the fog belt district at Spreckels, California and a third and even fourth brood were obtained in the greenhouse.

We determined the life history of the beet leafhopper at Manteca, situated in the Northern end of the San Joaquin Valley. A detailed study of the life history was started with the dark adults which wintered over in the cultivated area and the work with the successive generations was conducted during 1919-1920. No breeding experiments have been conducted on the plains and foothills to determine the number of broods, and we are assuming that the first pale green adults which invade the cultivated area represent the first or spring generation. After the first

[1] BALL, E. D., 1917. The Beet Leafhopper and the Curly Leaf Disease that it Transmits. Utah Agr. Exp. Sta., Bul. 155, pp. 1–56.

[2] SEVERIN, H. H. P. 1919. THE BEET LEAFHOPPER. A Report on Investiga tions into its Occurrence in California. Facts About Sugar, VIII, No. 7, pp. 130-131. 134; No. 8, pp. 150-151; No. 9, pp. 170-171; No. 10, pp. 190-191; No. 11, pp. 210-211; No. 12, pp. 230-231; No. 13, 250, 255.

[3] SEVERIN, H. H. P. 1919. Investigations of the Beet Leafhopper (*Eutettix tenella* Baker) in California. Jour. Econ. Ent., XII, No. 4, pp. 312-326.

flight of the pale green adults into the cultivated regions during 1919, the number of generations was again ascertained. Various phases of the life history determined in cages were checked up in the cultivated area and on the plains and foothills for a period of four years.

The egg period was determined twice during each month from February to October. The incubation periodss varied from 11–55 days. the shortest egg periods occuring from July to September. Eggs deposited from November 1 to January 15, failed to hatch or the nymphs died out-of-doors during the winter. The eggs do not develop without fertilization.

Temperature plays an important role on the duration of the egg period. The mean temperature was 8°F. higher in the case of an egg stage requiring 44 days and extending from the winter into the spring, than the incubation period of 28 days in the autumn. The low winter temperature and humidity prolong the egg period but the rate of development is increased during the spring, whereas the high early autumn temperature increases the rate of early embryonic development and results in a shorter egg stage even with a lowering of the temperature later in the fall.

The nymphal periods of the first brood varied from 23–37 days from April to October. The egg and nymphal periods varied from 37–99 days. During the winter a high mortality of the nymphs occurred which hatched from eggs deposited during September and October.

Stahl[4] experienced many difficulties in determining the maximum number of eggs deposited by a single female and records the deposition of 237 eggs by one female at Spreckels and 247 eggs by another female at Riverside. To determine the number of eggs which a single female of the first brood deposits during her life, a male and female were confined in a cage enclosing a sugar beet. The male acquired the winged stage on May 8 and the female on May 9. The eggs were allowed to hatch and the total number of nymphs removed from the cage would equal the egg-laying capacity providing all of the eggs hatched. A total of 328 nymphs were removed twice during each month from June 15 to August 16. The female died on November 20.

Four generations were bred from the dark females which wintered over in the cultivated area. After the flight of the first brood from the plains and foothills into the cultivated area, four more generations were bred or a total of five broods. The months of maximum emergence of the first to the fourth broods bred from the dark females which wintered over in

[4]STAHL, C. F., 1920. Studies on the Life History and Habits of the Beet Leafhopper. Jour Agr. Research, XX, No. 4, pp. 245-252.

the cultivated area correspond to the same months in which the second to the fifth generations were reared from the pale green leafhoppers as follows: June-July; July-August; September-October and October-November.

The minimum preoviposition period of the first brood adults required three days during July at a mean temperature of 80.3°F. The preoviposition period of the dark overwintering females varied from 3-4½ months, hence no eggs were deposited during the autumn. The following percentages of dark females collected during the winter on the Coast Range had fully developed eggs in the ovaries: December 4%; January 52-64% and February 86-99%.

The longevity of 60 males and 40 females of the spring brood collected on April 28, 1919 on the plains near the foothills of the Coast Range was determined in a cage out-of-doors and varied as follows: males, three months; females, four months. The longest adult life of four generations which were bred varied as follows:

Brood	Males	Females.
First	4	9–10 months.
Second	4–11	5–12 months.
Third	7½	11 months.
Fourth	4	8 months.

The longevity of the dark overwintering adults can be determined approximately under natural conditions. Dark specimens first make their appearance in August in the cultivated area and are abundant from September to November. The first marked reduction in the number of dark males occurred during December in both the cultivated area and on the plains and foothills and from February to March, males are very rarely taken. The length of adult life of the dark males is about four months. The first marked reduction in the number of dark females occurs during March and April. In all probability, the last dark females are at the end of their natural life by the time that the pasture vegetation becomes dry. It is doubtful whether any dark females which flew to the plains and foothills during the autumn, return to the cultivated area during the spring. The longevity of the dark overwintering females is about seven or eight months under natural conditions. It is evident that the longest adult life in cages, of four broods which were bred, is greatly prolonged and does not occur under natural conditions.

Light colored adults rarely winter over. Some specimens collected on the plains and foothills from October to January had mature eggs in the ovaries, while others like the dark females, winter over without depositing eggs during the autumn.

The dark males follow the females to the plains and foothills, mate during the autumn and die during the winter. During the spring, however, most of the first brood pale green males remain behind on the plains and foothills and probably die after the pasture vegetation becomes dry. After a flight had occurred during the spring, 8% of the specimens collected in the cultivated area were males and 92% were females. After the invasion of the spring brood into the cultivated area 92% of the females had mature eggs in the ovaries.

OBSERVATIONS ON THE BIOLOGY OF APPLE APHIDS

By FRANK H. LATHROP, *Associate Entomologist*
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It not infrequently happens that methods of treatment which have been used with great success in the control of insect pests in one section of the country prove inadequate when applied in some more or less distant section. Moreover, certain treatments, such as oil sprays, which are used with comparative safety in one section, may be too injurious to permit of their general use in another section or under different climatic conditions. These apparent discrepancies may usually be explained upon the basis of variation in behavior of the insect pests or of the orchard trees in reacting to the dissimilar conditions of climate, topography, or other environmental conditions of the two regions.

It is therefore desirable, in the study of insect pests, to compare, whenever possible, the characteristic behavior of the insects in different sections of the country.

During the seasons of 1915 and 1916, the writer had opportunity to study, at the Geneva Station in Western New York, the three species of aphids, (*Aphis avenae* Fab., *Aphis pomi* De G., and *Aphis sorbi* Kalt) which are commonly injurious in apple orchards. Since 1917 these observations have been continued in Western Oregon. This study, made in districts so widely separated and so distinctly different in climate, has brought out several interesting facts relative to the behavior of these insects.

RELATIVE ABUNDANCE OF THE SPECIES

Probably the first difference to be noted is the relative abundance of the several species in the two regions.

In western New York, *Aphis avenae* is normally the most abundant of the three species. Although the actual injury from this species is

slight because of its low toxicity upon apple, the species, nevertheless, produces a heavy and conspicuous infestation, especially upon the blossom clusters, where it occurs in enormous numbers.

In the fruit districts of the Willamette Valley, Oregon, this species is rare upon apple, and each spring a thorough search has been necessary in order to find even a single colony in any of the orchards in which examinations were made. Apparently this same condition applies in California.[1] However, the species occurs more or less commonly on grains and grasses in both Oregon and California. This seems to indicate that the species is not conspicuous as an apple pest in regions where the climate permits wintering on grains or grasses.

Next to *Aphis avenae*, *A. pomi* is the most abundant in apple orchards of Western New York. The species increases in abundance during midsummer and young plantings as well as the more succulent portions of mature trees frequently suffer severe injury.

In Western Oregon, *Aphis pomi* is by no means uncommon, but severe injury from this species is not of frequent occurrence. The greatest abundance occurs in early summer; later in the season, infestation usually subsides to a minimum.

Aphis sorbi is by far the most common species in Western Oregon, while in Western New York, it is ordinarily the least numerous of the three. Because of the high toxicity of this species upon apple, and because of its habit of malforming the fruit, this is a serious pest wherever it occurs. The great abundance of this species under normal conditions in Western Oregon ranks this insect with the codling moth as one of the major pests of the apple.

HATCHING

Spring advances rapidly in Western New York with a proportionally rapid hatching of the eggs of the aphids under consideration. The gradual approach of spring in Western Oregon is accompanied by a long hatching period. There is a corresponding and even more striking prolongation of the intervals between the hatching periods of the several species.

During the spring of 1916 *Aphis avenae* began hatching in the locality of Geneva, N. Y. on April 22; *A. pomi* on April 26, a difference of four days. *A. sorbi* was intermediate between these two, but there was so little difference in time that the hatching of the two species appeared to occur almost simultaneously. Baker and Turner,[2] working at Vienna,

[1] Swain, Albert F., A Synopsis of the Aphididae of California, University of California, Tech. Bul., Vol. 3, No. 1, pp. 94, 95, 1919.

Virginia in 1915, observed a difference of eleven days between the beginning of the hatching period of *A. avenae* and that of *A. pomi*. Peterson[3] studying these species in New Jersey in 1919 observed a difference of fifteen days between the beginning of the hatching periods.

In Western Oregon, the hatching of *Aphis pomi* begins from nine to fifteen days later than *A. sorbi*. The extreme scarcity of *A. avenae* in the orchards under observation here has made it impossible to determine the exact date of hatching; however, it occurs, certainly from ten to fifteen days prior to the hatching of *A. sorbi*. This makes an interval of from nineteen to thirty days between the hatching of *A. avenae* and *A. pomi*.

The length of the hatching period shows a similar regional variation. Baker and Turner record a period of seventeen days between the hatching of the first and last eggs of *A. pomi* in Virginia. At Geneva, N. Y.[4] in 1916, hatching began on April 26 and was completed by May 2, a period of six days. At Corvallis, Oregon, in 1921, the eggs upon one tree under observation began hatching March 20, and continued to hatch until April 18, a period of twenty-nine days.

Summer Activities

The most pronounced regional difference noted in the behavior of these aphis during the summer months occurred in the time of appearance of the winged forms.

At Geneva, N. Y., in 1916 the second generation of *Aphis avenae* consisted entirely of winged individuals, and the species quickly disappeared from the apple. Baker and Turner,[5] reported 98.1 per cent of the second generation winged at Vienna, Virginia in 1915. At Corvallis, Oregon, in 1919 the wingless forms were very few in the second generation. They became predominant in the fourth generation.

Aphis sorbi shows a tendency in this same direction, which accounts to some extent for the more serious nature of the pest under Western Oregon conditions.

During the summer of 1919, specimens of *A. sorbi* were placed on a young apple tree enclosed in a cheesecloth cage. This cage was kept constantly moist, thus reducing the temperature, raising the relative humidity, and inducing the tree to continue a rapid and succulent growth.

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[3]Baker, A. C. and Turner, W. F., Morphology and Biology of the Green Apple Aphis *In* Jour. Agr. Research, V, pp. 955-993, 1916.

[4]Peterson, Alvah, Response of the Eggs of *Aphis avenae* Fab. and *Aphis pomi* De G. to Various Sprays. *In* Jour. Econ. Ent., XII, pp. 363-386, 1919.

[4]Parrott, P. J., Hodgkiss, H. E., Lathrop, F. H., N. Y. Agr. Exp. Sta. Bul. 431, p. 40, 1917.

[5]Baker, A. C. and Turner, W. F., Apple-Grain aphis, In Jour. Agr. Research, XVIII pp. 311-324, 1919.

The wingless viviparous females were produced throughout the summer and were present until killed by frost in late November. So far as could be determined, there was no tendency to produce oviparous forms in the fall, and there was no indication that the species could maintain its existence upon apple for more than one season without the aid of the plantain forms.

Aphis pomi also shows a regional difference in the production of winged forms. Baker and Turner found that "in the second generation, the winged form outnumbers the wingless" in Virginia. During the spring of 1916, the writer observed colonies at Geneva, N. Y. in which at least ninety per cent of the second generation developed wings. This high percentage of winged forms in the second generation seems characteristic of *A. pomi* under Eastern climatic conditions. The scarcity of winged forms of later generations is equally characteristic.

Observations in Western Oregon show that there is much less tendency to thus segregate the development of winged forms. In this section, winged forms are usually not numerous in the second generation. Here the migratory forms are much more numerous in the later generations than is the case in the East.

Winter Activities

The hibernation of *Aphis pomi* as observed in Oregon shows no conspicuous variation from the behavior of the species elsewhere.

Aphis avenae in Western Oregon winters principally as viviparous females on grains and grasses, where growth and reproduction take place during the winter months when the temperature permits. Comparatively few migrants appear on the apple in the fall and hibernation in the egg stage on apple is uncommon.

Aphis sorbi in Western Oregon produces numerous migrants which return to the apple in the fall, and are normally sufficient to produce a severe infestation. However, in this section, only a portion of the plantain forms become winged in the fall. A considerable percentage remain on plantain throughout the winter months. Reproduction and growth continue during the winter, although reduced to a very low rate. Specimens born in the insectary at Corvallis, November 27, matured February 10— a developmental period of seventy-four days.

Wintering on plantain is apparently normal with this species in the climate of the Willamette Valley, for infestation has been observed in the field throughout every winter since 1917. During the winter of 1919–20, *Aphis sorbi* on plantain in the field, where protected by snow, withstood a temperature of thirteen degrees below zero. Where there is no pro-

tection, the species succumbs to a much less vigorous temperature.

With the approach of spring, the overwintering forms on plantain become more active, and winged forms are produced to spread the infestation.

Economic Considerations

The effects of regional variation in the behavior of apple aphids are of direct significance to the commercial fruit grower. The more severe injury to apple orchards normally resulting from attacks of *Aphis sorbi* in Western Oregon, makes the control of this pest in this section even more imperative than in regions where injury is less pronounced.

As a rule, *Aphis pomi* is less injurious in orchards of Western Oregon than in the New York fruit districts, and in normal seasons causes the Western Oregon orchardist little concern.

Aphis avenae is of no importance as an apple pest in Western Oregon.

By wintering on plantain, *Aphis sorbi* becomes independent of apple in Western Oregon. The continuous breeding on plantain produces a source of supply of these insects, which serves as a reservoir for the species, and which accounts in part for the greater infestation of apples in this region. Any campaign which might be undertaken for the actual eradication of the species from Western Oregon would have to be waged against the plantain forms as well as the infestation on apple.

In Western Oregon the greater capacity of *Aphis pomi* for dispersal in the later generations would probably greatly interfere with the control of this species during seasons of unusual abundance.

The most unfortunate effect, however, of the regional variations noted is the failure of the standard "delayed dormant" treatment to successfully control *Aphis sorbi* in Western Oregon in spite of the success with which this treatment is applied in the East. The unsatisfactory results which are attending the use of the "delayed dormant" spray of nicotine sulphate for the control of *Aphis sorbi* in the Willamette Valley are probably due to the long-drawn-out hatching period more than to any other factor.

LIFE HISTORY OF THE CODLING MOTH IN WALNUTS AT SANTA ANA, CALIFORNIA

By H. J. Quayle

Life History

Wintering Larvae. The larvae winter in cocoons beneath the loose bark of walnut trees, in old pruning cuts, under bands, if such are present,

in trays and other places into which the larvae can squeeze for protection. They are inactive in these cocoons until early spring, when they remodel their cocoons so as to furnish exit tubes for the moths.

SPRING BROOD OF PUPAE. On April 6th counts and estimates made in the field indicated that in the walnut, about 10% of the wintering larvae had pupated, while about 15% of those in the apple had pupated. On April 19th about 20% had pupated from walnut, and 30% from apple. The last pupation of this brood occurred on June 19 from walnut, and about 10 days earlier from apple. The length of this stage varies from 18 to 30 days.

SPRING BROOD OF MOTHS. The first moths were seen in the field on April 24. The maximum emergence was about June 1st, and the last emergence record from the apple was June 20th, and from the walnut, June 30th.

THE FIRST GENERATION

FIRST BROOD OF EGGS. The first eggs observed in the field were on May 8th on pears, May 12th on apples, and May 14th on walnuts. The maximum number of eggs was present on apple about June 1st, and on walnuts about June 10th. It has been noted this year, as in other years, that eggs occur earlier on apple than on walnut, and that eggs of this brood continue to be deposited until early in July. The time of incubation ranges from 10 to 20 days.

FIRST BROOD OF LARVAE. The first eggs observed to hatch was on May 17th on apple. The peak of appearance of the larvae on walnut was during the 2nd week of June. A large majority of the first-brood larvae enter, or attempt to enter at the calyx end of the nut. Before all of this brood enter, however, the nut becomes too hard (3rd week of June) at the calyx end and entrance is sought at other points, particularly where two nuts are in contact. The time spent in the nuts will average about 35 days. Some of this brood of larvae were still in the nuts 69 days after entrance, and even then showed no signs of spinning until they were disturbed by cracking the nuts. Such records were noted on August 18th and an occasional larva of this brood pass the winter before transforming. Definite records to this effect have been noted at Carpinteria and Santa Ana.

FIRST BROOD OF PUPAE. The first pupation of larvae that had hatched in the spring was observed on June 15th. The majority of this

brood pupated during the latter half of July. The period spent in the cocoon varied from 6 days to several weeks, but most of the specimens transferred in 10 to 12 days.

FIRST BROOD OF MOTHS. Moths from eggs laid in the spring begin to appear on June 25th, maximum July 30, last September 1st, or later. Moths from the spring brood are still present at this date, so that there begins an overlapping of broods that persists and becomes more pronounced as the season advances. In fact, the overlapping may continue into the following season, since larvae of two or three different broods may pass the winter together.

The data given for the first observed appearance of the eggs, larvae, pupae and adults, are not necessarily for the same insect, nor do they represent the first actual appearance of the different stages, but only the "observed" appearance. For example, the moth that emerged on June 25th pupated earlier than June 20th, the date of the first observed pupation. The maximum emergence of this brood occurred about July 30th. The length of life of the moth varies from 5 to 18 days, the males dying much earlier than the females.

THE SECOND GENERATION

SECOND BROOD OF EGGS. The first eggs of the second brood were seen on July 3rd. During the last week of June and the first two weeks of July, while occasional eggs were deposited, egg laying was at a minimum during this period. Beginning the third week of July, eggs became more numerous and the peak of egg laying by this brood was during the first week of August.

SECOND BROOD LARVAE. Second brood larvae began to appear early in July and reached their maximum numbers about the second week of August. One larva which hatched on June 30, pupated on August 18, which represented the shortest larval life observed, 20 days. Under the heading "*First Brood Larvae*" a record was given of 69 days in the larval stage in summer and even at the end of this period, spinning seemed to be induced only by disturbance. Many of the second brood larvae pass the winter as such, and do not complete their development until the following year.

SECOND BROOD PUPAE AND MOTHS. Some of the second brood larvae transform to the pupa and adult, the first of which may appear the last week of August and continue to appear until October.

The Third Generation

Third Brood of Eggs and Larvae. Eggs and young larvae of this partial brood, appear in September and October. Recently hatched larvae have been observed to enter the nuts as late as the second week in October. When the nuts are harvested, while most of the larvae are mature, many will be found in various stages of development.

Seasonal Life History at Santa Ana

The wintering larvae in their cocoons began to change to the pupae late in March and continue to pupate until the middle of June. The first moths appear during the middle of April, the peak of emergence occurs about June 1st, and the last of the brood emerges. The peak of egg laying by this spring brood of moths occurs the first week or two of June, while the first week of May and the first week of August represent respectively, the beginning and end of the brood. The peak of the appearance of the larvae occurs about June 10, while May 15 and July 15 represent respectively the beginning and end of the brood. The peak of the appearance of the moths of the first brood occurs the first week of August. Second brood eggs appear in maximum numbers August 10th. Second brood larvae second week of August, and second brood moths the last week of August. Eggs and larvae of the third generation appear in September and October. The wintering larvae include those of the first second and third broods. Since a few larvae of the first brood showed no indication of spinning until disturbed on August 18, 69 days after hatching, as well as other records, indicate that some of the larvae of the first brood do not transform until the following year. There is but one full brood and a partial second and third brood of eggs and larvae. Since, however, larvae of the first, second and third broods overwinter, there is left but one complete generation of the insect with a partial second and third.

Seasonal History at Carpinteria

While an occasional specimen will appear at Carpinteria almost as early as at Santa Ana, the great majority appear much later at Carpinteria. In 1919 the peak of appearance of the spring brood of larvae was during the first and second weeks of July. In 1920, a warm spring, the peak occurred about the third week in June. There is only a partial second brood of larvae at Carpinteria and no third brood, so far as observed. At Santa Ana the greatest amount of injury is done by the second brood larvae in late July, August, and early September, while at Carpinteria the greatest injury is done by the spring brood during the

latter part of June, July and August. Nuts containing the spring brood larvae were collected in July, and while some of the larvae transformed to the adult, some remained in their cocoons throughout the season and the following winter. There is thus only one complete generation of the insect at Carpinteria and a partial second.

COLD STORAGE CONTROL OF INSECTS

By E. R. De Ong, *University of California.*

The thought of insect control in stored products is usually associated with a gross infestation followed by a hasty attempt to kill all insects present by fumigation or other means. Such practice implies a certain amount of injury by insect feeding, but this in itself may be small compared with the loss from impaired appearance and the resulting prejudice of the purchaser of such infested packages, irrespective of whether or not the insects present are alive or dead. And the higher the plane upon which a specific brand rests, by reason of expensive advertising, the greater will be its fall, if that brand becomes the symbol for "worm eaten" goods. After the injury has been accomplished, the killing of the destructive insect cannot replace the loss in weight, remove the frass and webbing or restore the damaged fiber; neither is reinfestation prevented by fumigation or heat, no matter how carefully the work is done. Prevention is needed rather than cure, – we want insurance against all loss by insects and if fungi and bacteria can be included, the greater the value of the treatment and this is what cold storage may accomplish.

A cooperative experiment between the California Associated Raisin Co. and the University of California has been completed, wherein raisins were stored from four to five months at temperatures ranging from 10° to 48° F. The summary of the report for the entire storage period as made by the technical expert of the Association is a follows:

"It would seem from the foregoing that keeping raisins in cold storage at all temperatures of 10° to 48° F. will prevent infestation, but does not prevent sugaring, but the lower the temperature at which raisins are stored the less they are sugared."

"Also that raisins brought from any degree of cold storage to 50°F for 36 hours and then to 70° F. are in a slightly better condition than those brought directly from cold storage to 70° F. temperature".

"All of these samples were in good merchantable condition, there being no fermentation, insects, or mould present."

It is well known that at a low, constant, temperature insects are dormant and the prolonged exposure at a still lower degree may cause death.

which state may be reached even more quickly by sudden alternations from low to high and the reverse. Experiments, to secure definite data of this nature, were conducted on the different stages of the insects commonly attacking dried fruit, viz., *Plodia interpunctella* Hubn. (Indian meal moth), *Carpophilus hemipterus* Linn. (dried fruit beetle), *Silvanus surinamensis* (saw toothed grain beetle), *Tenebrioides mauritanicus* Linn. (cadelle) and *Carpoglyphus passularum* Hering. (dried fruit mite). No eggs were available at this time so this part of the work remains to be completed. Dried prunes, raisins and figs, infested with the above mentioned insects, were placed (just as they came from the storeroom packed in 50 pound boxes) in the experimental storage plant where the daily variation in temperature is less than one degree. The temperature in the different rooms being 10°, 25°, 32°, 36° and 45° to 50° F. Every thirty days one or two boxes of fruit were removed, their contents examined, and a count made of all insects found and their condition noted. Dead specimens were discarded to prevent their being counted the second time, if it became necessary to make a count in this box in the future. It was thought that this plan would better simulate conditions under practical operations rather than to place a counted number of insects in an artifically prepared feeding place. The total number of dead and living specimens was then taken as the basis for determining the percentage in the table. The total number of specimens in each species was not always as large as desired and as a consequence the curve is not as symmetrical as it would otherwise be. A summary of the data as given in Tables I and II does not distinguish between larva, pupa, and adults, but in the original record the variation between the stages was not great, the mature form of the larva of both beetles and moths seemed to be the most resistant of any. The few mature caterpillars which attempted to pupate during the storage period invariably died.

TABLE I MORTALITY RATE BY TEMPERATURE
(Summary of all species)[1]

Length of Exposure	10°F. %	25°F. %	32°F. %	36°F. %	45-50° F %
1 month	100	98.7	80.6	86.5	0
2 months	--	99	88	100	0
3 months	100	100	100	100	83
4 months	100	100	100	100	85.8
Mites 4 months	100	42	45	--	3

TABLE II MORTALITY RATE BY SPECIES
(Summary of Temperature Record)

Name of Insect	One Month %	Two Months %	Three Months %	Four Months %
Plodia interpunctella	72.4	77.1	91.8	62.5
Carpophilus hemipterus	76.0	100	100	100
Silvanus surinamensis	41.0	87.3	100	100
Tenebrioides mauritanicus	—	—	—	100
Carpoglyphus passularum	—	—	—	72

[1]Total number of specimens observed. *C. hemipterus* 294, *S.surinamensis* 1133, *T. mauritanicus* 35, *P. interpunctello* 404, *C.passularum* 3909 (estimate).
[2]The irregularity is explained by the fact that only 40 specimens were found at this examination, 15 of which were larvae in the room 45°-50° F.

From this data, it will be seen that a constant exposure of three months or more at any degree from 10° to 36° F. has proven fatal to the three stages of all insects experimented upon; two years prior to this a somewhat similar experiment was conducted with a total mortality rate of 96.5% in the third month and 100% in the fourth month. It may be concluded then, that dried fruit stored at any temperature from 10° to 36° F. will be free from all injury by insects during the time of storage and when removed at the end of the third or fourth month all stages of the insects experimented upon (unless it be the egg) would be dead. The action of bacteria and fungi would also apparently be suspended during the time of storage. A temperature of 45° – 50° F. causes dormancy, but only a low mortality.

Such a plan for handling dried fruit would give protection during the summer months, when practically all the loss occurs, so that hold-over stocks for use during the summer or speculative material that was being stored until another year could be held without risk of loss by insects. Stocks remaining in storage for three or four months would be practically sterile, from the insect standpoint, when removed. This is not a new principle, but an application to a field where it has not been commonly practiced. The dealers in furs have long used cold storage as a summer protection for their stocks and in 1907 Circular No 36, of the U. S. Bureau of Entomology was issued by C. L. Marlott, giving temperatures at which the activities of the clothes moth are checked but he speaks of mortality only with alternating temperatures.

The practical application of cold storage must include the comparative cost of chilled and normal temperatures (dry storage). A comparison of the rates as established by the California railroad commission shows a range in price per ton, for a season of 6 months as follows:

Cold storage–75c. to $1.00 per cwt. for 6 months season

Dry " (including labor) 11.1c. to 23.9c. per cwt. for 6 months season.

This is an average of 70 cents per cwt. or .7 of a cwt. per pound excess charge for cold storage. When the average retail price of dried fruit ranges from 20 to 30 cents per pound then the seasons insurance cost is from 2.3% to 3.5% of the value, and this cost will seldom be paid on any of the stock sold during the winter following the production of the fruit. Comparing this with the cost of insect protection during the growing season, we find that pear growers estimate the cost of one spraying as equivalent to 2 to 3% of the crop value with from three to six applica-

tions necessary, making a total protective cost of 6% -18% of the crop value. To summarize the insurance cost of the two periods, it is seen that:

Crop Protection during the growing season requires 6% - 18% of the crop value.

Crop Protection during the storage period is but 2.3% -3.5% of the crop value.

FOREST INSECT PROBLEMS OF THE PACIFIC SLOPE

By A. J. JAENICKE, *Forest Examiner,*
United States Forest Service, Portland, Oregon

Until very recently only fire protection was given serious consideration whenever forest protection matters were under discussion. The term forest protection meant protection against fire and only fire. Gradually, however; there has been an awakening, and today many of the owners of timberland on the Pacific Coast are convinced that at least in the pine stands, the Dendroctonus beetle menace is as great, if not greater, than the hazard of forest destruction by fire. This awakening has come because of the gradual increase in value of the remaining timber and the resultant more careful attention which is given its protection. The damage caused by the always spectacular forest fire is easy for everyone to see and understand, but many observant foresters and even observant entomologists fail to recognize the slower and yet more insidious losses which the bark-beetles bring about in our forests. The Forest Service has long realized the necessity for forest insect control but thus far the funds for such work on the National Forests have been inadequate.

For more than thirty years the federal Bureau of Entomology has investigated the character and extent of the damage caused by the Dendroctonus beetles to the forests of this country. The life histories of these tree-killing beetles have been worked out and methods of control have been developed by the Bureau which are of proven efficacy. The application of these control methods again and again has resulted in the protection of timber at a cost far within the limits of good business practise. Equipped with a knowledge of these control methods, both private and government agencies are now in a position to effectively protect privately and federally owned forests against bark beetle depredations if the necessary funds are at hand.

In British Columbia, Washington, Oregon and California the forest insect problem is most acute in the pine stands. Other species of trees are by no means immune but in the Pacific Coast region the destruction

to the pine timber far over shadows the insect loss prevailing in the other tree species. The major pine species involved in the Pacific Slope insect depredations are, in order of their importance: western yellow pine[1], sugar pine, western white pine and lodgepole pine. Only two species of Dendroctonus are of primary importance in the wholesale killing of these four species of pine; namely, the western pine beetle (*Dendroctonus brevicomis* Lec.) and the mountain pine beetle (*Dendroctonus monticolae* Hopk.). The western pine beetle infests only the western yellow pine while the mountain pine beetle kills with equal ease the four species of pine we have enumerated. Nevertheless the volume of western yellow pine killed in this region by *brevicomis* undoubtedly exceeds the total *monticolae* depredations in all the four species of pine under discussion.

Ordinarily one finds only relatively unimportant evidences of the activity of these two species of Dendroctonus in our yellow pine, sugar pine, white pine and lodgepole forests. Small and scattered attacks of this type are known as normal infestations and in the present intensity of forest protection no control work is done on such infestations. However, they should be carefully watched for any evidences of increase in the severity of the attacks. Occasionally the killing of trees by these two *Dendroctonus* beetles proceeds at an alarming rate and in such cases the prompt destruction of the beetles in the infested trees must be undertaken. These concentrated and heavy attacks are called epidemic infestations. Since existing epidemics have their origin in normal or endemic situations, it is not at all improbable that eventually, when forest protection becomes more intensive, the so-called normal infestation will come in for its share of control work.

It has been demonstrated that the safe control of epidemics is not a one year or even a two or three year matter. It is true that the effort is made to help the natural forces to break the force of the infestation by large scale control operations in the first year or two, but it is just as important that this initial control work be followed up by a certain amount of so-called maintenance work year after year. This maintenance work is inexpensive and serves to prevent the recurrence of the epidemic conditions. As our pine stands become more and more valuable, they will be divided into control units and a definite permanent plan of insect control will be worked out for each unit. In the Sierra National Forest, in California the Bureau of Entomology already has

[1]Western yellow pine –Pinus ponderosa
Sugar pine –Pinus lambertiana
Western white pine –Pinus monticola
Lodgepole pine –Pinus contorta

such a plan well under way, and in other parts of the Pacific Slope the initial outlining of control units of both private and government pine forests has already been completed.

Perhaps a single instance of the tremendous loss which the western pine beetle (*Dendroctonus brevicomis*) can inflict on the yellow pine of this region will suffice. One of the finest bodies of western yellow pine in the West is located in southern Oregon in the vicinity of Klamath Falls. It is a privately owned body of timber covering an acreage of about 600,000 acres and a volume of at least ten billion feet. Thirty million dollars is a conservative valuation of this property. During the past ten years the forest fire loss on this area amounted to only $15,000 because of the efficacy of the fire protection plan. During this same ten year period there has been a $3,000,000 loss for which the western pine beetle has been entirely responsible. In other words, during the last ten years the western pine beetle has killed ten per cent of the stand. This killing is still going on. A few of the private owners have attempted to control the beetle on their own lands but their work was futile because of the indifference of the owners of neighboring timber. Oregon has recently put a compulsory forest insect control law on its statute books and so the way has been paved to force the indifferent and careless timber owner into line. This particular body of privately owned yellow pine timber is surrounded by federally owned forests which are infested to the same degree as the private timber. As a consequence an effective control campaign must provide for the reduction of the beetle on the private and government lands simultaneously. An emergency appropriation bill has recently been introduced in both Houses of Congress which provides for the appropriation of the $150,000 which is deemed necessary for the wiping out of the beetle menace on the federal lands.

In British Columbia, the *Dendroctonous* infestations are being fought on a large scale on provincial, crown and grant lands. The timber owners of Oregon and California are becoming fully alert to the beetle danger. And it is probable that within the next few years, Congress will provide more money to enable those responsible for the protection of federal timber to fight the *Dendroctonus* epidemics in co-operation with the private owners. In the meantime, the splendid investigative work of the Bureau of Entomology on these forest insect problems must be financed on a better basis. Its handful of forest entomologists in the West have had the three-fold responsibility of giving advice in the field to timber owners and government officers, carrying on insect surveys over large areas and keeping under way their investigative work. Improvements

in control methods are being developed constantly at the Bureau's western experiment stations under the direction of Dr. A. D. Hopkins. These improvements mean cheaper protection and the investigative work which yields them should not be sacrificed. There is a real need for the study of forest insect problems by the state experiment stations. With the rapidly growing demand by the forest industry for advice on forest insect control, the necessity for the enlargement of the Bureau's personnel of forest entomologists and the need for the attention of the state experiment stations to the many still unsettled phases of the forest insect problem are already at hand.

BIOLOGICAL NOTES ON DESMOCERUS, A GENUS OF ROUNDHEAD BORERS, THE SPECIES OF WHICH INFEST VARIOUS ELDERS

By H. E. BURKE, *Specialist in Forest Entomology, Bureau of Entomology, U. S. Dept. of Agric.*

The Genus Desmocerus consists of four western and one eastern species. All bore in the pith and wood of living shrubs or trees of various species of elder (Sambucus). As some of the elders are used as ornamental shrubs or shade trees these insects which infest them are of interest as shade tree pests. Usually the stems mined by the borers do not die but sometimes they do and in any case the emergence holes made by the beetle cause unsightly scars in the bark and afford an easy entrance to wood destroying bacteria, fungi and ants.

In general the life cycle of Desmocerus is two years. Eggs are laid in crevices of the bark or around wounds and the larva does most of its boring in the pith of the stems. Lateral mines are made through the wood to the surface of the bark for throwing out borings and for the emergence of the adult. Pupation and the transformation to the adult take place during the second spring in a cell in the pith. The adults emerge about the time the elder is in bloom and may be found on the flowers or foliage. The best method of collecting them, however, is to cut into the stems just before the flowers open and take them from the pupal cells.

All of the species have been collected and studied to some extent by the writer. Special attention has been given to *cribripennis* and *californicus* because they occur in the Pacific region and because *californicus* causes damage to the blue berried elder which is a common dooryard shade tree in central California. Mr. R. D. Hartman of the Los Gatos Forest Insect Laboratory made a number of notes on the life history of *californicus* and Miss E. T. Armstrong of the Washington office collected most of the *auripennis* studied.

D. palliatus Forst.—Eastern states; both males and females blue except for basal third of elytra which is yellow; larva mines stems of common eastern elder (Sambucus canadensis); does not always kill the stem mined. At Brookland, D. C. a large larva was found in the pith at the base of a large stem on February 19, 1910, and an adult in a pupal cell in a similar position on May 19, 1913.

D. cribripennis Horn.—Washington, Oregon, California; both males and females dark green above, elytra with narrow orange margins; larva mines stems of the western red-berried elder (S. callicarpa), usually does not kill the stems mined; eggs are laid in crevices in the bark. The young larva upon hatching mines through the wood into the pith and up the pith until full grown. At irregular intervals lateral mines are made from the pith through the wood to the surface for throwing out borings, etc. When growth is completed the larva mines through the wood to the surface and then retreats back into the pith plugging the mine as it goes with shredded borings. After pupation and transformation take place the adult emerges through this mine. At Pialschie, King Co., Wash., pupation takes place in the spring and the adults emerge during April and May. Sometimes the young larvae will eat a large hole in the outer wood before entering the pith. Several larvae may live in one stem. The life cycle is two years.

D. californicus Horn.—California; male elytra bluish or purplish with distinct orange margins, female elytra velvety black or slaty with slight orange margins; larva mines stems of the blue berried elder(S. glauca) at lower elevations in the central coast regions of California; usually does not kill the stems mined; the adult feeds on the foliage. Common around Los Gatos, Palo Alto and Guadaloupe in Santa Clara County. Egg is 3.5mm. long, 1.25mm. in dia., white when first laid, turning to brownish white and reddish brown; oblong, pointed at both ends, points terminating in knobs; surface marked by heavy, longitudinal wavy ridges which do not always extend from end to end, connected by lighter transverse ridges which are more prominent toward the ends; surface between ridges marked by large pits.

The eggs are laid in the crevices of the bark, tucked under the bark at scars or in the wood where small branches have been broken off. They are fastened on with a shellac like substance. Upon hatching the larva enters the bark near the shell or wanders for some distance before entering. Usually it mines through wood and into the pith as soon as possible but sometimes when in large trunks it remains in the wood until growth is completed. As the mine proceeds the larva makes lateral mines to the surface at irregular intervals for the purpose of throwing out

borings and other debris. When growth is completed the larva bores out to the surface, retreats for several inches, plugging the mine with shredded borings and forming a pupal cell in the pith. The larval stage lasts for about two years. Pupation takes place from January to April. The pupal stage lasts for about one month and the young adult remains in the cell for several weeks before emerging. The first adult was found in the pupal cell on February 20 and in the field on April 12th. The egg stage lasts from thirty to forty days. In the laboratory the female lays from eight to twenty eggs. The last beetle collected in the field was taken on May 19th.

D. piperi Webb.—Idaho, Washington, Oregon; male elytra entirely orange, female elytra bluish green with narrow orange margins, smaller species, 15 to 20mm. long; mines stems of black berried elder (S. melanocarpa). At Bourne, Baker County, Oregon, on June 29, 1910, males and females were common on the foliage of shrubs which had just blossomed. Many pairs were copulating.

D. auripennis Chev.—California; male elytra entirely orange, female elytra with broad orange margins but always with a darker blue green or purple discal area which may vary in size from a mere spot to one half the area of the elytra; larger species, 23 to 28 mm. long; mines stems of the blue berried elder (S. glauca) at higher elevations in the Sierras. Medium and large larvae were taken in the pith of the bases of stems of bushes near Ellis Meadows, Sierra National Forest, on May 16, 1921, at an elevation of about 5500 feet. One of the large larva pupated May 31 but failed to transform. Adults were taken in numbers on the flowers and foliage during July and August, 1914 and 1915, along the Lincoln Highway in El Dorado County, at an elevation of from 5000 to 5500 feet. Plants at lower elevations did not appear to be infested. The life cycle is two years, half grown larvae being found in July.

In case of damage the trunks of the trees to be protected should be sprayed the first of June with the Craighead arsenate of lead-miscible oil emulsion or some other good ovicide.

EUROPEAN CORN BORER CONFERENCE

Sandusky, Ohio and St. Thomas, Ontario, Canada, Sept. 15-17, 1921.

A meeting of entomologists and others interested was held at Sandusky, Ohio, Sept. 15, 1921, to consider the corn borer situation and to suggest a national policy. Dr. E. D. Ball presided and was relieved at some of the sessions by Dr. Herbert Osborn.

The sessions included comprehensive statements by the entomologists in charge of the various divisions of the Corn Borer investigations in the United States and Canada. W. R. Walton discussed the general situation and the object of the conference; D. J. Caffrey explained the experimental work being conducted by the U. S. Bureau of Entomology and the essential results obtained; L. H. Worthley reviewed the quarantine work and the value derived therefrom. Arthur Gibson discussed the situation in Canada; H. G. Crawford reviewed the significant facts brought out in the investigational work being conducted in Canada; L. S. McLaine reported on the scouting and quarantine operations in the Dominion. There followed a general discussion of the entire problem in which many of the conferees took part.

A committee was appointed to suggest recommendations as to the policy to be adopted in relation to national, state, local, and individual control. The committee (E. P. Felt, Chairman, Arthur Gibson, E. C. Cotton, W. P. Flint, J. J. Davis, R. W. Harned, and L. H. Worthley) submitted the following report which was adopted at the final session at St. Thomas, Ontario, Sept. 17, 1921.

Report of Committee on Policy

Economic Status. This conference of official entomologists of the United States and Canada views with grave concern the extensive spread of the European Corn Borer in 1921 and recognizes this insect as a menace to the agriculture of North America. The invasion this season into northern Ohio constitutes an immediate danger to the great corn belt of the country.

The natural spread of the insect and its establishment over large areas makes extermination impossible and we therefore advise the adoption of a policy designed to check further spread so far as possible and to promote the speedy development of practical control measures.

It is also our opinion, considering the advance in technical entomological investigations bearing on the development of control measures and the many agencies now available for the distribution of this information and the assurance of intelligent and energetic response, together with cooperation from the corn growers of the country, that it will be possible to greatly mitigate the damages that would almost certainly result from the unrestricted spread of the insect.

National Policy. We unhesitatingly recommend the continuance of quarantine measures as a most effective means of checking further spread.

We respectfully recommend to the U. S. Federal Horticultural Board the adoption of a modified regional quarantine in New England on account of the complex conditions due to the development of two generations in that area and the consequent infestation of numerous plants and would suggest establishing a quarantine line not farther west than the Connecticut river.

We respectfully suggest that quarantine restrictions in infested areas, where the Corn Borer normally produces but one generation annually, be limited to corn, all sorghums, Sudan grass and broom corn.

We also respectfully recommend to the Dominion of Canada Department of Agriculture, the continuance of the present policy in regard to quarantine measures as a means of control.

We would recommend very careful scouting of areas adjacent to the western infested districts bordering on Lake Erie (both in the United States and Canada) in order to speedily determine the extent of the infestation, since this would assist in formulating quarantine restrictions and aid in determining the policy in relation to control measures.

It is suggested that scouting work in territory adjacent to the infested areas in New England and New York be continued to such an extent as to determine quarantine lines.

STATE AND PROVINCIAL POLICIES. The closest possible cooperation in both quarantine and control work with federal authorities is urged.

State and Provincial quarantines should coincide with federal regulations.

The authorities in infested States and Provinces are urged to make financial provision for cooperative work since this may mean maximum participation on the part of the Federal Governments.

The attention of the State and Provincial officials is called to the desirability of utilizing the extension service and all publicity agencies in developing a proper attitude toward control of this pest and the importance of keeping the infestation in sparsely infested areas down to a practical minimum, particularly in strategic localities.

INVESTIGATIONS. It is understood that the U. S. Bureau of Entomology is now compiling a record of the history of this insect in European countries and it is hereby urged that this work be speedily completed and made available to American entomologists.

The recent great extension of the Corn Borer infestation and the need of the development of control measures in the immediate future leads us to urge the great practical importance of a close study of this insect, by North America entomologists, in various European countries in order that information thus obtained may be made available to the entomologists of America and by them applied to the solution of the numerous problems in relation to the control of this pest.

Inasmuch as all control work must of necessity be based upon exact knowledge of an insect, it is our opinion that facilities for investigational work and the introduction of parasites might be somewhat expanded.

The conference has noted with pleasure the close cooperation in both control and investigational work between the United States and Canadian officials.

METHODS FOUND OF VALUE IN CONTROL WORK. Cut corn close to the ground and as early as practicable.

Ensile entire crop whenever possible and this should include all waste from canning factories.

Shred or cut cornstalks before feeding, since this kills many borers and promotes consumption of the fodder.

Uneaten cornstalks, including corn stover in field, lot or barn, or parts of stalks, should be completely plowed under or burned by May 15. Such material should not be used for bedding or thrown into the manure.

Fall plowing, especially early fall plowing, thoroughly done, kills many borers.

Heavy rolling prior to plowing is suggested.

Burn weeds and grass in or near infested corn.

Early planted corn is most likely to become infested, consequently somewhat later planting usually results in relatively less injury.

The following were present: *Geo. G. Atwood, Dept. Farms and Markets, Albany, N. Y. *E. D. Ball, U. S. Dept. Agric., Washington, D. C., H. N. Bartley, U. S. Bur. Entomology, Silver Creek, N. Y., Erle G. Brewer, U. S. Bur. Entomology, Cambridge, Mass., *L. Caesar, Ontario Agricultural College, Guelph, Ontario, *D. J. Caffrey, U. S. Bureau of Entomology Arlington, Mass., *E. C. Cotton, State Dept. Agriculture, Columbus, O., *H. G. Crawford, Dominion Dept. Agric., Ottawa, Canada, C. R. Crosby, Cornell Univ. College of Agriculture, Ithaca, N. Y., *J. F. Cunningham, Ohio Farmer, Cleveland, O., *J. J. Davis, Purdue Univ. Agric. Expt. Sta., Lafayette, Ind., F. C. Fall, U. S. Bur. of Entomology, Stoneham, Mass., *Richard Faxon, State Dept. Agric., Elyria, O., *E. P. Felt, State Entomologist, Albany, N. Y., *F. A. Fenton, Iowa Agric. Expt. Sta., Ames, Iowa, W. P. Flint, State Nat. Hist. Survey, Urbana, Ill., *Arthur Gibson, Dominion Dept. Agric., Ottawa, Canada, *H. A. Gossard, Ohio Agric. Expt. Sta., Wooster, O., *R. W. Harned, Miss. Agric. College, Agricultural College, Miss., *J. S. Houser, Ohio Agric. Expt. Station, Wooster, O., P. A. Howell, U. S. Bureau Entomology, Berlin, N. H., L.L. Huber, Columbus, O., *M. B. Jimison, County Agric. Agent, Sandusky, O., *K. F. Kellerman, Federal Horticultural Board, Washington, D. C., W. H. Larrimer, U. S. Bureau of Entomology, West Lafayette, Ind., Floyd DeLashmutt, County Agric. Agent, Oak Harbor, O., *Russell Lord, Ohio State College of Agriculture, Columbus, O., L. S. McLaine, Dominion Dept. of Agric. Ottawa, Canada *E. W. Mendenhall, Bureau of Plant Industry, Columbus, O., *W. A. Orton, Federal Horticultural Board, Washington, D. C., *Herbert Osborn, Ohio State University, Columbus, O., *T. H. Parks, Ohio State University, Columbus, O., R. H. Pettit, Mich, Agric. College, E. Lansing, Mich., *Saul Phillips, U. S. Bureau Entomology, Cambridge, Mass., T. R. Richardson, U. S. Bur. Entomology, Albany, N. Y., G. A. Runner, U. S. Dept. Agric., Sandusky, O., *A. F. Satterthwait, U. S. Bur. Entomology, Webster Groves, Mo., *C. H. Sears, The Sears & Nicholas Canning Co., Chillicothe, O., *L. J. Tabor, State Dept. Agric., Columbus, O., R. A. Vickery, U. S. Bureau Entomology, Cambridge, Mass., *W. R. Walton, U. S. Bureau Entomology, Washington, D. C., *C. G. Woodbury, Bureau Raw Products Research, National Canners Assoc'n., Washington, D. C., *L. H. Worthley, U. S. Bur. Entomology, Cambridge, Ohio.

Those marked with an asterisk made the trip to Ontario Sept. 16-17, where an exellent opportunity was afforded to observe the ravages of the pest and to better form an opinion relative to the present and possible future status of the insect.

In Canada the party was joined by Dr. J. H. Grisdale, Deputy Minister of Agriculture of the Dominion of Canada and the following connected with the Dominion and Provincial Corn Borer Investigations, H. F. Hudson, W. N. Keenan, R. H. Painter, L. J. Simpson, and J. G. Spencer.

The secretary of the conference, J. J. Davis had the minutes of the meeting mimeographed and has a few extra copies which can be obtained as long as the supply lasts.

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The American Association of Economic Entomologists was organized at Toronto, Can, August 29, 1889 by James Fletcher, A. J. Cook, John B. Smith, Charles J. S. Bethune, L. O. Howard, Clarence M. Weed, E. Baynes Reed, H. Garman and C. W. Hargitt, although the first annual meeting was held at Washington, D. C., November 12th. The facts regarding the organization of the Association appear to have been largely overlooked and attention is called to them at this time because the coming meeting at Toronto is the first gathering of official Entomologists of the United States and Canada as an organization in Canadian territory since that historic time and moreover it happens that the sessions will be held in the same city and in conjunction with two other well known, nation wide organizations, the Entomological Society of Ontario, which celebrated its jubilee in 1913 and the Entomological Society of America. Arrangements have been made for meetings of these three organizations, each with its respective field and yet so closely related one to the other, that it is difficult to define sharply the spheres of influence, since one of our most prominent Entomologists expressed himself years ago to the effect: that All Entomology is economic. This is literally true. The work of the economic Entomologists, while more obviously practical and of immediate advantage, is dependent to a very large degree upon the efforts of the systematist in defining genera and species, particularly the latter. The entomological meetings at Toronto may not be so largely attended as those held near the great centers of population yet they promise to be exceptionally interesting not only from the historic side but on account of the presumably unusually large percentage of leading Entomologists likely to be in attendance. The occasion offers another excellent opportunity for cementing anew the ties of good fellowship and cooperation along scientific lines, which have prevailed since the early days of entomological work.

Current Notes

The annual meeting of the Alabama State Beekeepers Association was scheduled to be held at Montogomery on September 22.

Mr. W. E. Hoffman has been appointed instructor in economic entomology at the University of Minnesota, vice W. E. Cook, resigned.

The department of biology at Macdonald College has been divided, Professor William Lochhead retaining charge of the department of entomology and zoology.

The appropriation for the control of bee diseases in Florida is $10,000.00, this being exactly double the amount availablef or such work last year.

Professor T. Miyake, professor of zoology, Agricultural College, Imperial University of Tokyo, Japan, a well-known writer on entomological topics died February 2, 1921.

Mr. William Schaus, lepidopterist of the United States National museum, received the degree of Master of Arts, last June, from the University of Wisconsin.

Dr. Henry Fox who has assisted in control operations against the Japanese beetle at Riverton, N. J., has returned to college to resume his teaching duties.

Dr. Ira M. Hawley of the entomological department of Cornell University has been appointed professor of entomology and entomologist at the Utah College and Station.

Dr. Phillip Garman, New Haven, Conn., visited Philadelphia, and spent the week October 4-11, in studying the collections of Odonata at the Academy of Natural Sciences.

Mr. F. P. Ide, who was appointed temporary laboratory assistant, Entomological Branch, Canadian Department of Agriculture, during the summer months, resigned September 3, to continue his studies.

Mr. W. H. Goodwin who assisted the department of entomology of the Ohio Station during the summer months, has returned to his school duties at East Youngstown.

Mr P. R. Lowry, of Ohio State University, has been appointed assistant entomologist at the New Hampshire Station, vice. C. R. Cleveland, who has gone to De Pauw University.

Mr. H. M. Brundrett has been transferred from the Federal Horticultural Board to the Bureau of Entomology, and assigned to work on the ox warble at Herkimer, N.Y.

Mr. H. O. Woodworth, formerly horticultural commissioner of San Mateo County, California, has been appointed professor of entomology in the College of Agriculture in the University of the Philippines.

Mr. George Hopping has been appointed Insect Pests Investigator of the Entomological Branch, Canadian Department of Agriculture, and is attached to the Division of Forest Insects at Vernon, B. C.

Mr. R. L. Webster, formerly of the Iowa College and Station, who has just completed work at Cornell University for the degree of Ph.D., has been appointed entomologist of the North Dakota Station, beginning in August.

Mr. F. W. L. Sladen, Dominion Apiarist of Canada, was drowned off Duck Island near Kingston, on September 10. Mr. Sladen was formerly assistant entomologist in the Division of Entomology in charge of bee work, and is the author of many articles and a book on "The Humblebee."

Dr. Clarence H. Kennedy instructor in Entomology at the Ohio State University will remain for the present at that institution. In the April issue of this journal it was announced that he had been appointed instructor in Entomology at the University of Tennessee. This was an error and it is not known how the report originated.

The State Plant Board of Mississippi is issuing a quarterly bulletin modeled on much the same lines as that of the State Plant Board of Florida and the monthly bulletin of the California State Department of Agriculture. It is a welcome addition to entomological literature and is destined to fill an important place in the economic work of the country. The first number is dated April, 1921.

Dr. E. D. Ball has resigned as Professor of Zoology and Entomology at the Iowa Agricultural College and State Entomologist of Iowa, and as Assistant Secretary of Agriculture, to accept the permanent position of Director of Scientific work in the U. S. Department of Agriculture. He began his new duties October 1, 1921.

Mr. L. H. Worthley of the U. S. Bureau of Entomology, in charge of field experiments in controlling the European corn borer, Mr. J. G. Sanders, Director of the Bureau of Plant Industry, Harrisburg, Pa., and Mr. E. C. Cotton, Director of the Bureau of Plant Industry, Columbus, Ohio, visited the region infested by the European corn borer in Ontario during August.

Two short courses in beekeeping will be conducted in Colorado, by the College of Agriculture in co-operation with the United States Department of Agriculture. The first will be held at Fort Collins during the week of November 21, and the other at Grand Junction the following week. The instructors are Dr. E. F. Phillips, Geo. S. Demuth, Kenneth Hawkins, Wesley Foster and Frank Rauchfuss.

Announcement has been made of two short courses in beekeeping by the College of Agriculture, University of California, in co-operation with the United States Department of Agriculture. One will be held at some point in southern California during the week beginning December 5, and the other at Berkeley the following week. Dr. E. F. Phillips and Mr. Geo. S. Demuth are prominent among the instructors.

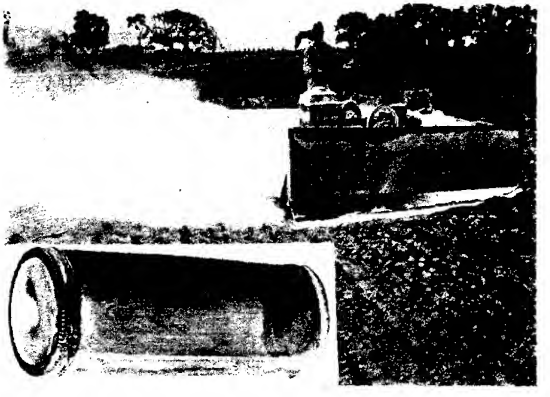
Mr. J. C. Bridwell, Bureau of Entomology, who left Washington last December for a study of the bruchid pests of the mesquite and closely related plants in Texas, returned from Brownsville to Washington during June with considerable parasitized material of *Acanthoscelides uniformis* and *Acanthoscelides sallaei*. Six hymenopterous parasites of these bruchids have been secured. Mr. Bridwell is at present preparing a report upon his work.

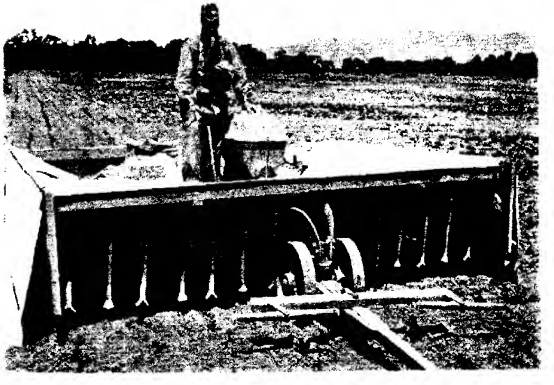
Mr. R. C. Treherne has been appointed Chief of the Division of Field Crop and Garden Insects of the Entomological Branch, Canadian Department of Agriculture, and will take up his duties at Ottawa in October. Mr. Treherne has been provincial entomologist for British Columbia, and was formerly connected with the central entomological work at Ottawa, when it was organized as a part of the Central Experimental Farms.

Mr. Dwight M. DeLong of the Bureau of Plant Industry, Harrisburg, Pa., has obtained a leave of absence and will teach elementary and economic entomology at the Ohio State University the coming year in place of Prof. C. L, Metcalf, who has recently gone to the University of Illinois. Mr. DeLong expects to receive his doctor's degree next spring and plans to return next summer to his work in Pennsylvania.

Professor M. D. Leonard has resigned as assistant professor of extension entomology at Cornell University to take effect November 1, 1921, to accept a position as field manager for the Bowker Insecticide Co., with headquarters at 49 Chambers St., New

PLATE 5.





York City. He will endeavor to make tests on the company's farms and in co-operation experiments with various growers of such materials as are now, or may be in the future, manufactured by the company.

The following men have recently been appointed to positions in the Bureau of Entomology:—W. W. Porter, Crowley, La.; Roland Cowart, Richard V. Hood, L. R. Lyle, George B. Ray, George L. Smith, W. A. Stevenson, Adolph Thomas, V. V. Williams, scientific assistants, boll weevil laboratory, Tallulah, La.; Ernest E. Russell, field superintendent in insect control, Gainesville, Texas; Dr. William Moore, formerly of the University of Minnesota to take charge of insecticide investigations against the Japanese beetle, Riverton, N. J.; W. E. Stone, sweet potato weevil work.

At the 31st annual meeting of the Ohio Academy of Science held at Cleveland, March 25-26, 1921, Prof. Raymond C. Osburn was elected President. The following entomological papers appeared on the program; Hemiptera of the Adirondacks; and Collecting in Southern Florida, by Herbert Osborn; Some Studies in Hessian Fly Emergence, by T. H. Parks; Notes on the Habits and Life History of *Galeatus peckhami* Ashm; and A New Ambrosia Beetle; Notes on the Work of *Xyloterinus politus* Say, by Carl J. Drake; Phylogeny and Distribution of the Genus *Libellula*, by Clarence H. Kennedy; Aids in Teaching Elementary Cytology, by Z. P. Metcalf; the Cytology of the Seaside Earwig, *Anisolabis*, by S. I. Kornhauser.

The following transfers in the Bureau of Entomology have been announced: R. T. Cotton, from Orlando, Fla., to Washington, D. C., Miss Marion Van Horn from truck crop insect investigations to stored product insect investigations; L. R. Lyle, G. B. Ray, I. B. Rutledge, G. L. Smith, W. A. Stevenson, J. V. Vernon, V. V. Williams temporarily from boll weevil force to Federal Horticultural Board; R. W. Wells, Herkimer, N. Y., to Dallas, Texas; S. H. Roundtree, Macclenny, Fla., to Brownsville, Fla; Perez Simmons to insects affecting meats; L. W. Brannon, H. B. Lancaster, D. M. Dowdell, Jr., F. R. White, bean beetle investigations, to plant quarantine inspectors in the same project; G. L. Garrision, Quincy, Fla., to Washington, D. C.

Resignations in the Bureau of Entomology are announced as follows:—J. B. Moorman, bee-culture investigations to accept a position at Austin College, Sherman, Texas; E. S. Prevost, So. Carolina, and N. I. Lyle, Iowa, extension specialists in bee-culture; A. D. Shaftsbury, bee culture investigations to resume graduate studies in zoology at Johns Hopkins University; Louis R. Schreiner, field assistant, Carlisle, Pa., to complete his studies; F. D. Parnell, W. R. Smith, boll weevil force; J. W. Hendry, sweet potato weevil work, Macclenny, Fla; L. M. Prichard, sweet potato weevil work, Gulfport; L. P. Hodges, Alexander G. McCarty, J. N. Crisler, S. N. Boyd, boll weevil force; the following temporary appointments have been terminated; W. R. Heard, J. B. Pope, H. C. Young, Tallulah, La., and Charles Milford, Madison, Fla.

Mr. J. S. Houser, co-operating with C. N. Nellie, Park Entomologist of Cleveland and the U. S. Aviation Service, of McCook Field, Dayton, August 4, conducted a dusting experiment at Troy, Ohio, on a six-acre catalpa grove which was being defoliated by the catalpa sphinx. The poison was delivered from an aeroplane and the six acres were dusted in 54 seconds. An examination made six days later, showed 99 per cent. of the caterpillars were killed. It is believed that this method of distributing poison will be found very useful for treatment of large, close planted forest areas for foliage-eating insects such as gipsy moth. It may be useful for treating large orchards of big pecan and walnut trees, but can hardly take the place of liquid spraying in apple and peach orchards.

Mr. H. F. Willard, Bureau of Entomolgy, who has charge of the Honolulu office of the Federal Horticultural Board, is investigating the bruchid pests of the lagaroba bean as his inspection duties permit. When he sailed from San Francisco, July 20, he carried with him several lots of pods of huisache (*Vachellia farnesiana*), secured by Bridwell, in which was breeding the huisache weevil (*Acanthoscelides allaei*) and its parasites. Mr. Willard arrived in Honolulu July 27 and reported, on July 30, that the parasites, *Urosigalphus bruchi* and *Horismenus* sp. were emerging in good numbers on his arrival at Honolulu, and that between July 27 and 30 he had secured over 300 specimens of *Urosigalphus* and 1,000 specimens of *Horismenus* sp. On July 30, 94 females and 113 males of *U. brauchi* were liberated and immediately began searching algaroba pods for bruchid larvae. On August 7, Mr. Willard reports having reared from the Texas material, besides the two species mentioned above, *Glyptocolastes bruchivorus* and *Lariophagus texanus*. The work in Honolulu is being done by Mr. Willard in co-operation with D. T. Fullaway, entomologist of the Hawiian Board of Agriculture and Forestry.

The Mexican bean beetle caused larger losses this season than usual in the Estancia Valley in New Mexico. Reports by county agents and several growers show that about 5,000 acres of beans were totally destroyed, and the amount of damage is conservatively placed at $100,000.00. Reports by several of the growers and by Dr. Robert Middlebrook, entomologist of the State Agricultural College, State College, N. Mex., indicate that the insect was held in check to some extent by dipterous parasites. An investigation of this report was made, but it was too late in the season to determine absolutely whether a parasite had been at work. As a general rule, the Mexican bean beetle, in its occurrence in New Mexico, confines its attacks to the edges of the large plantings that lie close to the hills. During the present year severe damage resulted in the middle of the Estancia Valley, many miles from the mountains, and the bean growers are fearful lest the insect will repeat its attacks other years. The bean harvest in the West was almost completed by September 10 and many of the beetles were in the fields but none of them could be found in hibernation in the shrubbery in the foothills.

A hearing was held in Washington, D.C., on October 11, at 10:00 o'clock, A. M., before the Federal Horticultural Board to consider further steps necessary to prevent the spread of the European corn borer, which has been discovered this summer along the south shore of Lake Erie in Ohio and Pennsylvania, where it probably drifted from the infestation north of the lake in Ontario. The States of Maine, New Hampshire, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Ohio, Indiana, Michigan and Mississippi were represented. The following entomologists were present:–W. C. O'Kane, New Hampshire; R. H. Allen, Massachusetts; W. E. Britton, Connecticut; E. P. Felt, C. R. Crosby, New York, T. J. Headlee, C. H. Hadley, New Jersey; J. G. Sanders, Pennsylvania; E. N. Cory, T. B. Symons, C. C. Hamilton, Maryland; H. A. Gossard, E. C. Cotton, T. H. Parks, Ohio; F. N. Wallace, Indiana; R. H Lobdell, Mississippi; L. O. Howard, C. L. Marlatt, W. R. Walton, A. L. Quaintance, J. A. Hyslop, L. H. Worthley, D. J. Caffrey, E. H. Siegler and J. S. Wade of the Bureau of Entomology; Dr. E. D. Ball, Director of Scientific Research of the U. S. Department of Agriculture. There were between 50 and 60 present, including a number of plant growers, and representatives of State departments of agriculture; the writer did not keep a list of all, but noticed Prof. L. R. Taft, Michigan; Dr. G. G. Atwood, New York, Dr. A. W. Gilbert, Massachusets; L. H. Healey, F. E. Blakeman, Connecticut. The speakers were practically unanimous in asking that the present system of Federal quarantine be continued and extended as may be necessary to include the infested areas, but that no large uninfested territory be included in the quarantined area.